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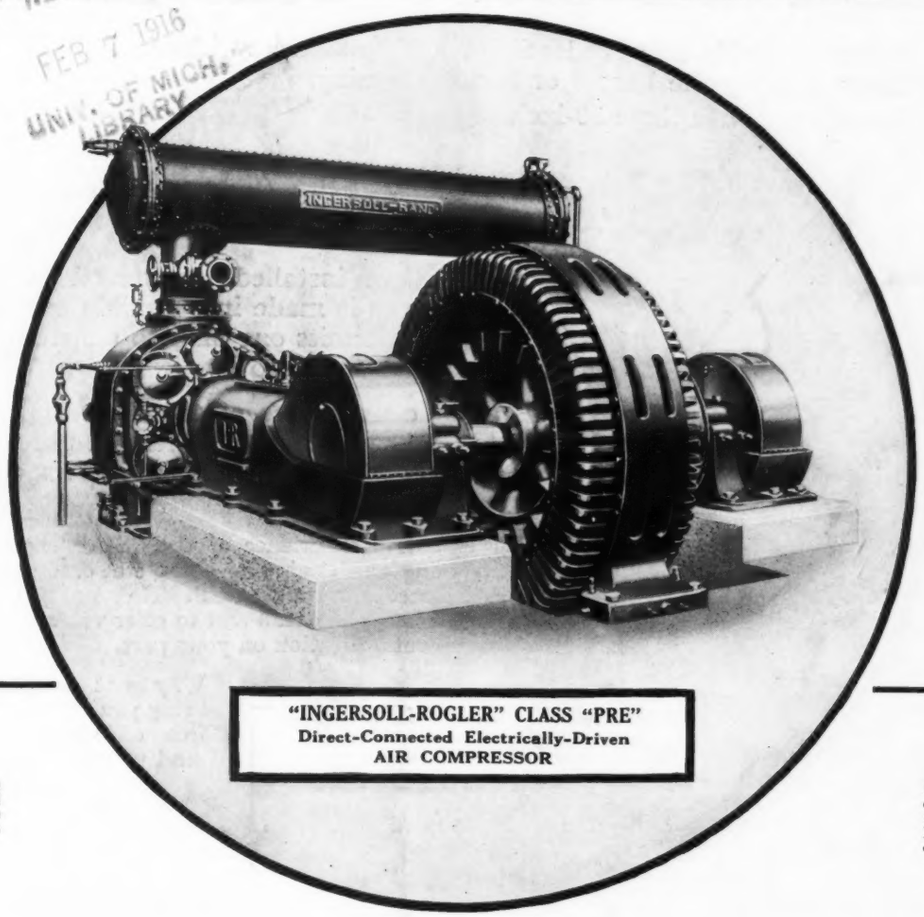

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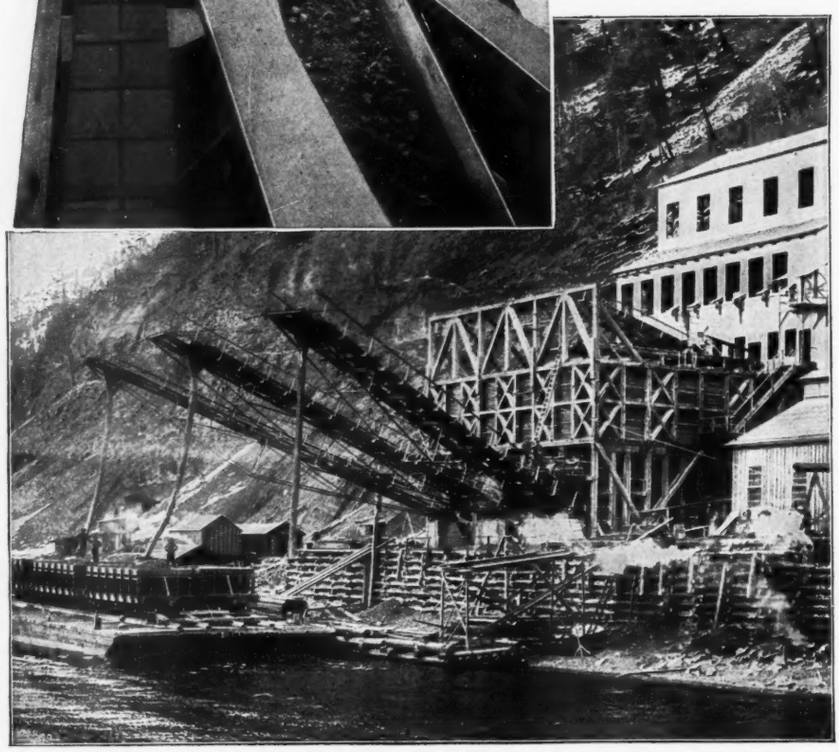

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Mining Journal

VOLUME 101 FEBRUARY 5, 1916 NUMBER 6

The Nevada Packard Mill

By Robert B. Todd*

SYNOPSIS—Description of the latest mill to be completed in the Rochester district of Nevada. It is a 100-ton, all-sliming cyanide plant, in which there are no stamps. Gyratory breaker, roll and tube mill perform crushing and grinding service. The Merrill precipitation system is used.

Construction of the Nevada Packard mill, at Rochester, Nev., was begun about the middle of August, 1915. The plant has been completed, and a test run was made with entirely satisfactory results. It was constructed under the direction of K. Freitag, who will continue in charge of the property. The mill is directly below and between the portals of two working tunnels, thus placing it advantageously for handling direct from the main source of ore supply. The slope of the millsite and the general arrangement of the plant permit the transfer of the solution and pulp principally by gravity.

The Nevada Valley Power Co., from its substation at Rochester, supplies power for the plant operation and lighting. There are a 100-hp. motor for driving the tube mills, a 60-hp. for the crushing machinery, a 60-hp. for the mine air compressor and drills and a 30-hp. motor for the filter vacuum pump and the machinery in the lower part of the mill. In addition there are two 10-hp. units for driving the Dorr machinery and precipitation-press pump, 5 hp. for driving the tailings conveyor, and a 3-hp. motor is used in the assay office. A 30-hp. boiler is placed below the mill for heating purposes during the winter months; oil is used for fuel. The property is equipped with an uptodate assay office and the necessary storerooms, repair shops, camp buildings, etc. An efficient fire system has been provided, with 24 hydrants inside and outside of the buildings. The foundation of the buildings are concrete on solid rock.

The main building is 64 ft. wide and 140 ft. long, with an addition 40x42 ft. for the tube mills. The crushing plant, 24x32 ft., is 80 ft. from the mill. The buildings are constructed of Oregon pine and are completely covered with 1-in. boards and then covered with asbestos roofing and siding.

The ore of the Packard mine is a silicified schist interspersed with quartz stringers. As broken, it is of a soft, friable nature and is easily crushed. The principal value is in silver and of a form readily acted upon by cyanide, the treatment giving a high extraction in a short time. The gold is free and associated with quartz.

THE NEVADA PACKARD MILL AND CYANIDE PLANT AT ROCHESTER, NEV.

The ore from the mine is trammed in cars to the crusher plant, where it is weighed on recording scales. A small amount of lime is added and it is then dumped into one of the two circular steel ore-bins, 12 ft. in diameter by 16 ft. high. The ore is fed from the bins to a No. 5 McCully gyratory crusher, where it is reduced to about 1¼ in. in size, and it is then elevated by a bucket elevator to a revolving screen with ⅜-in. square open-

*Mining engineer, Hotel Golden, Reno, Nev.

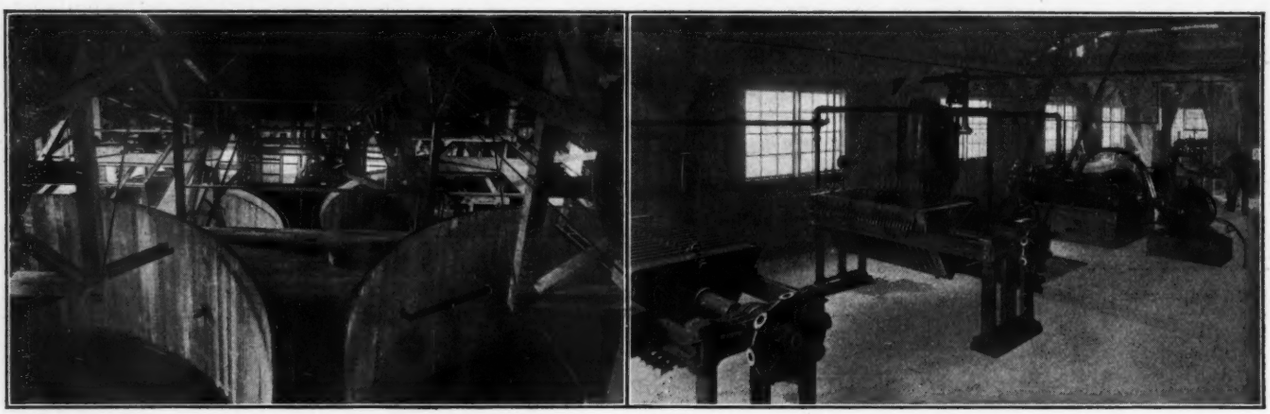
ings, the fines passing through the screen and the coarse through a 36-in. diameter by 16-in. Garfield roll, where it is reduced to a size that will permit it to pass through the screen. It is then conveyed on a belt 14 in. wide from the crusher plant to a 100-ton circular steel mill bin, from which it is fed by means of a steel-apron feeder, to a tube mill 6 ft. diameter by 5 ft. long.

Crushing previous to this point has been dry, but cyanide solution is added with the ore at the head of the tube mill. After leaving the first tube mill, the pulp is discharged to a Dorr classifier, where the fine slime is removed. The sands are delivered to a 6x10-ft. tube mill in which they are reground. The pulp is again returned to the classifier and continues in this way until every particle of ore is ground to 200 mesh, when it is discharged from the classifier as slimes. The extraction of the values begins from the time the solution comes into contact with the ore at the beginning of the tube-mill circuit. Tests indicate that over 85% of the values were in solution at the end of this operation. After leaving the classifier the slimes are elevated by a Frenier pump to Dorr thickener No. 1; the pulp entering this tank, which is 28 ft. in diameter by 10 ft. deep, contains five parts solution to one part of slime ore. It is allowed to settle in the tank, the thickener pulp being discharged continuously to the top of a 28x16-ft. Dorr agitator. The remaining solution overflows into a clarifier equipped with canvas leaves, and passing through them, it enters the pregnant-solution tank perfectly cleared and ready for precipitation.

A triplex pump transfers this solution to two Merrill precipitating presses. A quantity of zinc dust is introduced into the suction of the pump, and the precipitates are deposited in the presses and removed therefrom about every two weeks. The melting is done in a refinery—a separate building with an oil-fired furnace. The solution discharged is now free from gold and silver and is used for washing pulp as it enters thickener No. 3, returning to agitator No. 1, where the pulp entered from thickener No. 1. It is now agitated by compressed air and mechanical stirrers for 24 hr. and is discharged continuously to agitator No. 2, which is also 28 ft. diameter and 16 ft. deep, where the same operation takes place.

When the pulp has undergone 48 hr. agitation, the extraction of the silver is complete. The separation of the solution carrying the silver from the slimes then follows. This is done in thickener No. 2, 28x10 ft. The pulp flows continuously from agitator No. 2 into thickener No. 2 and is thence transferred to thickener No. 3 by a diaphragm pump. The barren solution from the presses unites with the pulp in thickener No. 3 and is thoroughly mixed therewith, collecting silver dissolved during the agitation, overflows to thickener No. 2, where the same operation takes place, and then overflows to the sump tank, from which point it is pumped to the stock tank for restandardization and used again in the tube mills.

The flow through these thickeners is a counter-current decantation, the pulp moving in one direction and the solution in the opposite. The pulp on leaving thickener No. 3 flows to an Oliver continuous filter operated on the dry-vacuum system, where the remaining solution is removed. The slime cake formed on this filter is thoroughly washed with fresh water and then discharged upon a 12-in. belt conveyor that transfers it to the waste dump. The operation of the mill requires two men on each 8-hr. shift. These men handle the crushing plant as well as the cyanide plant and also look after the mine compressor—placed in the mill. The compressor power load and the crushing-plant load will balance each other, the compressor plant being operated on two shifts and the crushing plant on one shift, in this way maintaining a uniform load. The plant has been designed to treat 100 tons of ore per day.



THE THICKENING AND AGITATING TANK ROOM AND THE PRECIPITATION DEPARTMENT AT THE NEVADA PACKARD MILL AT ROCHESTER, NEV.

Gold Dredging in 1915

On page 101 of the *Journal* of Jan. 8, 1916, Mr. Cranston quotes from United States Geological Survey reports to the effect that the dredges in California produced 86% of the total gold output of the state in 1914; this should have read 86% of the placer-gold output of the state. The dredges in California produced 37.69% of the total gold; the output of all placers, dredges included, was 43.97% and of the lode mines 56.03% of the total gold won in California during that year.

Huelva Copper Co., Spain, according to the official statement for the financial year 1914-15 shows a profit of £5,441 as compared with a loss of £6,505 in the preceding year. The deficit of £2,677, carried forward from the previous year, has been wiped out by this profit, leaving a net surplus of £2,764.

Colloids and Colloidal Slimes*

By E. E. Free†

SYNOPSIS—A detailed explanation of what colloids are and what they are not, the first step toward their proper understanding. Since all ore-dressing requires the handling of colloids, and particularly flotation, which deals principally with finely divided solids, this discussion is important as providing a basis for intelligent theorizing.

It is customary to begin a discussion of the practical applications of some phase of purer science by extolling the industrial importance of the particular scientific investigations or conclusions of which one happens, for the moment, to be protagonist. Such cajolery would be wasted on the present subject. Indeed, in coming to metallurgists with talk of colloids there is more need for caution than for invitation. In the current literature, especially that of ore dressing, few expressions are used so loosely as the word colloid. Without deprecation of the present importance and future promise of the results of colloidal investigations, it may be remembered that not all unsolved problems involve colloidal factors. There is too much tendency to "explain" obscure and little understood phenomena by reference to mysterious "colloidal substances" which, remaining themselves unknown, leave the problem precisely where it was before. It seems that most of this loose employment of the term colloid arises from certain misconceptions that seem to be widely prevalent concerning the physical and chemical nature of colloidal bodies. The task of criticism is never a grateful one, but the field must be cleared of remnants of discarded theories, and it seems that we can best approach the present subject by examining certain current conceptions that have fallen under suspicion.

The Mystery of the Colloids

In the field of ore dressing the conception of colloids that seems most seriously wrong takes, in the main, three manifestations. First is the idea that colloids are specific substances contained in an ore or produced by treatment of it—substances that are "present," "set free", or "destroyed" and that are spoken of quite as glibly as one speaks, for instance, of an ore containing or not containing sulphides or carbonates. Second is the theory that colloids are bodies possessing a peculiar quasi-chemical "affinity" for water manifested by a tendency to remain dissolved or suspended, by a reluctance to part with associated water, and the like. Third is the belief that colloids form gelatinous, glue-like films about the particles of ore or gangue and cause them to coalesce or to behave in other unusual ways. Let me illustrate these conceptions—as I believe, these misconceptions—by quotations chosen intentionally from some of the most admirable papers that have appeared in this field. Thus the late Doctor Ashley said: "By the term 'colloidal' is meant everything not crystalline. It includes everything covered by the term amorphous. In clays and soils the crystal grains are enveloped with a coating of gelatinous colloidal matter. The same is true of slimes."[1] De Kalb says: "Every grain will be found enveloped by a film of colloid in addition to that which may be present as free colloid, either as gel or sol, in the solution."[2] Caetani says: "A colloid is an amorphous substance of gelatinous nature having a well-marked chemical affinity,"[3] and again, "The colloid of one ore will generally differ substantially from the colloid of another ore."[4] Hayden says: "The colloids are hydrated amorphous substances resulting from the decomposition of some of the ore constituents, as kaolins, feldspars, etc."[5] It is useless to multiply illustrations. In the articles cited and in scores of others one sees a prevailing conception of colloids in ores as specific, chemically individual substances of gelatinous nature and possessing affinities and other properties not usual to ordinary crystalline mineral fragments. All three of these conceptions can be traced, I think, to a mental confusion between the so-called colloidal properties exhibited by ores and the properties of the well-known gelatinous substances encountered in everyday life and typified by glue, gelatin and egg-albumin, these substances happening to have been called colloids also. As a matter of fact it is definitely known that there are wide and important physical differences between the everyday gelatinous substances that one thinks of as colloids and the materials encountered in metallurgical practice. The first essential in approaching a study of the latter is to forget that the glue-like colloids have anything to do with the case.

It must be remembered, of course, that we are not particularly concerned with matters of words. Whether one calls a thing "colloid" or calls it something else is unimportant. The precise definition of the word colloid is a matter concerning which the lexicographers of colloid science have not been able to agree, but this particular fight is outside of our fence.[6] What concern us are certain properties of ores and of intermediate metallurgical products. These properties chance to have been called colloidal, but we are not very much interested in that; it is the properties themselves that matter. One is quite welcome to define a colloid as a specific substance of some definite kind, as a substance having a certain affinity for water or as a substance capable of forming gelatinous films. We shall not argue about the correctness of these definitions. The only objection is that these things do not explain (completely, at least) what happens in ores, and if the term colloidal is to be restricted to one or other of the groups so defined, then the properties of ores that here concern us are something other than, or something more than, colloidal.

If the arraignment of the current conceptions of what happens in the ores concerned (since we are not con-

*This is the first of a series of articles on "Colloids in Ore Dressing," treating of the behavior of colloids in metallurgical processes. The next article will be on "Sedimentation and Flocculation," and will appear in the "Journal" of Feb. 19, 1916.

†Chemical engineer, 1105 Madison Ave., Baltimore, Md.

[1] "Trans. A. I. M. E.," Vol. XLI, p. 381 (1910). Cf. Ashley, "Min. and Sci. Press," Vol. XCVIII, p. 831 (1909).

[2] "Min. and Sci. Press," Vol. C, p. 57 (1910).

[3] Ib., Vol. CVI, p. 438 (1913).

[4] Loc. cit., p. 439.

[5] "Trans. A. I. M. E.," Vol. VLVI, pp. 243-4 (1913).

[6] It is quite analogous to the discussion over the precise meaning of the word "slime." See Richards, "Ore Dressing," pp. 1397-9 (1909), and Young, "Trans. A. I. M. E.," Vol. XLII, pp. 752-4 (1911).

cerned with words, I avoid saying current conceptions of colloids) is to rest on anything more than personal assertion, we must go a little more deeply into the details of the phenomena, and it will be best to do this concretely. The place in which the metallurgist thinks most about colloids is in connection with refactory ores, in that slimes produced from them settle slowly or not at all and are handled with difficulty by the usual metallurgical procedures. From the viewpoint of the conceptions I am criticizing, these troubles are regarded as due to specific colloidal substances present in the ore or produced by grinding, these substances usually being regarded as gelatinous and amorphous (in distinction to crystalline) and as coating the mineral particles with slimy, adhesive layers. Frequently this colloid envelope is conceived as of gelatinous silica. Disregarding these guesses, for they are nothing more, let us consider what is actually known. The ore has been ground to more or less fine particles, and these are suspended in water that contains, usually, dissolved traces of the various substances present in the ore. Nothing else is actually known to be present. I am not aware that any identifiable colloid differing in any particular form ordinary mineral particles has ever been extracted from such a refactory ore.[7] So far, therefore, as we actually know, we are dealing with a suspension of fine mineral particles in an aqueous medium, and with nothing else.

The Properties of Suspensions

The query is why the normal properties of such a simple suspension, without reference to mysterious, intangible colloids, do not explain the properties exhibited by the slime? The answer is, they do. To drag into the case any concept of specific colloidal substances, of quasi-chemical affinities or of gelatinous surface films will but confuse the issue. I am aware of no experience encountered with troublesome slimes that does not admit of explanation on the basis of the properties of suspensions of mineral grains.

It may be well, parenthetically, to forestall disagreement by saying at once that in criticizing the concept of gelatinous envelopes about the mineral grains, it is not intended to exclude the possibility of surface alteration of these grains, such as had been observed, for instance, by Cushman.[8] The very wetting by water of a mineral surface produces certain physical changes, some of which have possible importance in slime phenomena. These it will be necessary to analyze in a later article. It is manifest, however, that such surface alterations are merely part of the phenomena accompanying suspension, are not to be considered apart from the grain whose surface they affect and are very different from an envelopment of the grains by discrete films of alien material. In no sense can such surface alterations or the altered surface materials be regarded as specific colloidal substances having any analogy to the glue-like colloids of the familiar organic group. It may be noted, also, that it is not improbable that surface gelatinous films of alien material, similar to those erroneously conceived active in slimes, do actually exist in certain natural clays and agricultural soils.[9] In these cases, however, the films are of materials that can scarcely be expected to be present in slimes, and no actual evidence of their presence has ever been adduced. As before, a supposed but baseless similarity is productive of confusion rather than of clarity.

Relation of Suspensions and Colloids

It is apparent that the properties of suspension will form the foundation for attack on the problem of colloidal slimes, and it is fortunate that suspensions have been studied thoroughly by geologists, soil physicists and the specialists in colloids. The most weighty result of this study is the conception of the possible existence of suspensions of smaller and smaller particles[10]. It is possible to prepare suspensions of clay or other minerals the particles of which are so fine that they remain permanently suspended, though still distinguishable by microscopic examination. It is a small step from this to the typical colloidal solution that appears free of particles ("optically empty") before the microscope, and the investigations of colloidal solutions made possible by the ultramicroscope,[11] which have been carried out during the past decade, have established very firmly the conclusion that the typical colloidal solution, as for instance, the well-known solution of colloidal gold, is simply a suspension the particles of which are extraordinarily small.

The important concept here is that of the perfect continuity of the suspension series. There is no natural break or division of any kind between a suspension of coarse gold fragments in water and a colloidal solution of gold particles so fine as to remain permanently suspended and be microscopically invisible.[12] It is quite possible to prepare a suspension of any intermediate degree of fineness. Indeed, if one regards ordinary solutions as composed of single molecules or ions moving through the mass of the solvent, these "true" solutions appear simply as the limiting case of the suspension series—suspensions in which the particles have become so small as to reach the dimensions of the molecule or the ion.

The immediately obvious objection to this concept of the unity of the suspension series from the coarse, visible suspension at one end to the true solution at the other is that the properties of the systems differ markedly in different parts of the series. A mixture of coarse gold particles and water is very different physically from a colloidal gold solution, and both differ in properties from a solution of, for instance, gold chloride containing the gold ion. This is quite true, but close examination of the series shows that all differences are of degree only. For instance, in a coarse-sand suspension, the most evident controlling factor is gravity. Nothing but the continuous expenditure of energy (as, for instance, by shaking) will keep the sand suspended. As we consider suspensions of finer particles, gravity grows less and less important, while simultaneously the surface forces between the particles and the aqueous medium grow more and more

[7] Indeed, analyses by Hayden of entire slimes at Anaconda and of colloidal matter washed therefrom showed very similar compositions, the only important differences being that the colloidal matter was noticeably lower in sulphur and in metals, slightly lower in silica and slightly higher in alumina than the entire slime. Hayden, loc. cit., pp. 243, 247.

[8] United States Department of Agriculture, Bureau of Chemistry, Bulletin 92, pp. 12-16 (1905).

[9] See Ashley, United States Bureau of Standards, Technologic Paper 23: 33-34 (1913), and Cameron, "Journ. Phys. Chem.," Vol. XIX, pp. 1-13 (1915), with literature cited by these authors.

[10] For details see Ashley, United States Geological Survey, Bulletin 388 (1909), and Bureau of Standards, Technologic Paper 23 (1911), and the general works cited in the appended bibliography.

[11] Siedentopf and Zsigmondy, "Ann. Physik," Ser. 4, Vol. X, pp. 1-39 (1903). In English see Zsigmondy, "Colloids and the Ultramicroscope," translated by Alexander, 1909.

[12] Zsigmondy, "Erkenntnis der Kolloide," pp. 97-127 (1905).

important until presently gravity yields control to these other forces and the particles remain in permanent suspension without external assistance. This behavior with regard to gravity is typical. The changes are always gradual as one passes up or down the series; they always result from continuous increases or decreases in the intensity of affecting factors. They are never abrupt. From the practical viewpoint, however, it is precisely these gradual changes of degree that are important. To return to the matter of colloidal difficulties with ores, the fact that the properties of the finer-grained suspensions do differ from those of the coarser is what has attracted attention. It is important theoretically to know that the differences are of degree rather than kind, but that does not dispose of the differences. Let us consider more precisely what they are.

The troublesome properties of colloidal ores reduce, in the main, to two—slow settling of slimes, which also means imperfect separation of finer and coarser particles, and low permeability of settled slime masses, filter cakes and the like. The latter is usually accompanied by a high retention of water in the thickened slimes. Both of these are comparative rather than absolute. The colloidal slime settles slowly and packs imperviously by comparison with slimes that are, as we say, "less colloidal." It is easy to demonstrate by experiment with suspensions of known character that slowness of settling and the other troublesome properties increase gradually and continuously with decrease of the particle size, and it is an obvious inference that unusually small size of particle is the cause of all the trouble with colloidal ores. The mechanisms may be pictured by recalling that in dilute suspensions gravity becomes less important and surface forces more important as the particles decrease in size, and that in thickened slime masses, if the particles are very small, the spaces between the particles are similarly tiny and offer tremendous frictional resistance to the percolation of water.

Anomalies of Colloidal Slimes

These effects of small particle size are so manifest and so manifestly sufficient to explain the facts that I suspect no other explanation would have been thought of were it not for certain surprising anomalies that have been observed and that may be grouped under two heads: (1) The degree of colloidal troubles encountered with different slimes seems, very frequently, to have no close relation to the amount of grinding; and (2) there is similar lack of correspondence between the troublesomeness of the colloidal properties and the percentage of very fine material in the slime as determined by screen tests or other more or less direct methods. The second of these has little weight. Not only are screen tests notoriously inaccurate, but the difference between a colloidal and a noncolloidal slime may be conceived as due to differences within that finest portion which in both cases will pass the finest available screen. The fact that colloidality of the slime frequently shows no determinable relation to the thoroughness of grinding is more important. Especially has the attention of engineers been focused on the frequent circumstance that of two ores ground and treated exactly alike, the one will yield a highly colloidal slime, the other a slime that is not at all troublesome. An example is the experience on the Rand that partly weathered ore yields a troublesome. colloidal slime, while the fresh unweathered banket does not.[13] Similar in implication is the experience cited, among others, by Caetani[14] that a sand washed free from colloidal slime and then reground usually does not again produce a colloidal slime. At first sight these experiences imply strongly that some peculiar colloidal substance is present in these troublesome ores.

But such presence of peculiar substance is not the only way in which the facts can be explained. There are two factors known to be active, both of which are competent. These are (1) the variable ease of disintegration of ores and (2) the coalescence of fine particles to form more or less permanent aggregates or granules. The variable ease of disintegration of ores is essentially a matter of mineral composition. Mechanical grinding by itself cannot reduce ore particles beyond a certain limiting size, which is probably considerably above the particle size necessary for high colloidality. If disintegration occurs beyond this limit of mechanical grinding, it is because the ore or some of its constituents are of such physical nature as to disintegrate spontaneously when shaken with water, as, for instance, clay will disintegrate. Natural processes of weathering in the oxidation zone tend to produce materials that will so disintegrate, as, for instance, when feldspar is altered to kaolin. The fact that weathered ores usually give more highly colloidal slimes than do fresh ores is easy to understand on this basis.

The fact that some weathered and easily disintegrated ores do not give colloidal slimes is explained by the second factor, the aggregation of particles. Technically this is known as flocculation. The aggregates, or floccules, behave in most ways like single larger particles, and the high colloidality proper to the disintegrated ore is counteracted by the flocculation. This matter is of extreme practical importance and will be discussed in detail in the next article of this series. I may say now that the two factors of variable ease of disintegration and variable flocculation are competent to explain all anomalous colloidal slimes that have come to my attention. It is permissible to believe it improbable that there exist any cases of colloidal slimes not explainable by these factors and by other well-known properties of suspensions. The hypothesis of specific gelatinous substances is both unnecessary and without direct support.

A Conception of Colloids

In summary of what precedes, we have developed a conception of colloids that regards them simply as suspensions of very fine particles.[15] The misconception of colloids as specific gelatinous substances possessing unusual quasi-chemical affinities we have criticized because it rests upon unsupported hypothesis and because it is unnecessary and confuses a matter not otherwise obscure. We have made no sharp distinction between suspensions and colloidal solutions. The emphasis, indeed, is quite the reverse and is on the unity of this series rather than on any possible severalty. As always,

[13]See, for instance, Caldecott, "Journ. Chem. Met. Min. Soc. S. Af.," Vol. VII, p. 217 (1907); Spicer, "Met. and Chem. Eng.," Vol. XI, p. 410 (1913).

[14]"Min. and Sci. Press," Vol. CVI, p. 441 (1913).

[15]The detailed experimental evidence supporting this conclusion is ample and beyond question, but its discussion would require too much space. It will be found in detail in the works of Freundlich, Ostwald and Zsigmondy cited in the appended bibliology. It is excellently summarized by John Johnstone in his introduction to Ashley's monograph on the "Technical Control of the Colloidal Matter of Clays," United States Bureau of Standards, Technologic Paper 23 (1913).

our insistence is on properties rather than substances. Certain colloidal properties, among which we have emphasized slowness of settling and imperviousness of the settled mass, characterize suspensions of finer grain. These we call colloids. The distinction is purely relative. We mean that these suspensions are more colloidal than those usually encountered.

For the purposes of purer science more precision of definition is necessary, and there has come to be nearly general agreement on a set of size limits given in the following table:[16]

CLASSIFICATION OF SOLID PARTICLES

Suspensions.....Particles over 0.1 micron in mean diameter
Colloidal solutions,
Particles between 0.1 and 0.001 micron in mean diameter
True solutions..Particles under 0.001 micron in mean diameter

While these limits are purely arbitrary, their use is convenient as indicating the range of particle size within which the typical colloidal properties are best developed. It is not implied that these properties cease entirely to be exhibited by suspensions the particles of which lie outside these limits. In metallurgy especially it is necessary to consider many important extensions of colloidal properties into the field of the coarser suspensions. Nearly all slimes, even the most colloidal, belong in the field of suspensions rather than in that of colloidal solutions as these fields are defined by the size limits given.

This particulate conception of colloids leads immediately to a further conception, which is really the chief characteristic of these bodies and is at the bottom of most of their properties—the conception of great internal surface. It is manifest that if a colloid is composed of very fine particles of one substance suspended in another, the total surface of contact between the two substances will be very great. This mutual surface is called the internal surface. It has been found that a number of peculiar properties, of which surface tension is the best-known example, characterize all surfaces where two substances come into contact,[17] and the great extent of such surface in suspensions and colloids gives these surface properties and forces an unusual importance in controlling the salient properties of the entire system. For instance, the phenomena of absorption or the concentration of dissolved substances at surfaces are exhibited in a high degree by suspensions and colloids and are of much technical importance in dyeing, the clarification of wines, the manufacture of contact sulphuric acid and in many other industrial processes. A metallurgical illustration is the stubborn retention by slimes of the last traces of cyanide solution and of dissolved gold.

In speaking of the large internal surface of colloids one means, of course, that the surface is relatively large with respect to the masses involved. The criterion is a large ratio of internal surface to mass. Formal definitions are of no great value, but it is possible to define a colloid from this viewpoint as a mixture of at least two substances the internal surface of which is very large relative at least to the mass of one of the substances. It may be pointed out again that the definition is purely relative. What ratio of surface to mass is to be considered "very large" will depend upon circumstances. The larger the ratio the more colloidal the substance.

In the foregoing paragraphs there has been much mention of colloidal properties, but the only ones that have been discussed specifically are the slow settling of colloidal slimes and their imperviousness when settled. From the standpoint of ore dressing these two are the most important of all colloidal properties, and our emphasis is not unjustified. However, several other properties are of interest and deserve brief review. Most important scientifically are the similarities to, and differences from, the true or ordinary solutions the particles of which are supposed to be of molecular or ionic dimensions. The typical colloidal solution resembles a true solution in being permanent so long as conditions remain unchanged. That is, the particles remain in suspension and the colloidal solution retains an unchanged chemical composition. The colloids differ in (1) failure to show a true and constant solubility; (2) an optical heterogeneity shown by translucence or turbidity; (3) the causing of no change, or a very small change, in the freezing point and boiling point of the solvent; (4) the production of no osmotic pressure; (5) slow diffusion and failure to dialyze or pass through a parchment membrane. The causes of all these differences will be evident on consideration of the difference in particle size which distinguishes the colloids from the true solutions. Details need not be pursued further than to say that the differences, as before, are of degree only. Colloids do not fail entirely to show the typical solution properties, but they show them to so slight a degree as to escape all but the most painstaking and exact researches.

Of other properties of colloids, flocculation and adsorption have already been mentioned. Another of much technical importance is the tendency of the colloidal particles to wander in the electric field and accumulate at one or the other of the poles. This is distinguished from ordinary electrolysis by the fact that the passage of current is not essential. The matter is one of electrostatics and occurs in nonconducting media. It forms the basis of the well-known Cottrell process for the collection of acid and smelter fume, the removal of dust from stack gases, the separation of oil globules from condenser water and the like.

The Classification of Colloids

In what precedes, the reader has probably detected a tacit assumption that all colloids consist of solid particles suspended in a liquid medium. It is easiest to attain an initial concept of the nature of colloids by regarding them in this way, but the concept is incomplete. Common experience furnishes numerous examples outside this simple case. For instance, the usual medicinal emulsions of cod-liver oil, or, to use an illustration with pleasanter associations, the ordinary oil-vinegar salad dressing consists of globules of oil suspended in an aqueous liquid. Obviously both particle and medium are liquid, yet the properties of the mixture are (with some exceptions in detail) the typical colloidal properties. As a matter of fact it is possible to prepare suspensions and colloidal solutions the particles of which are either solid, liquid or gaseous and which are suspended either in solid, liquid or gaseous media. In 1907 Ostwald[18] published a classifica-

[16] Zsigmondy, "Erkenntniss der Kolloide," p. 22 (1905). A micron is one-thousandth of a millimeter, or approximately one twenty-thousandth of an inch.

[17] See, especially, Freundlich's "Kapillarchemie," cited in the bibliography.

[18] "Grundriss der Kolloidchemie," first edition, pp. 94-7 (1907).

tion of colloids on this basis, and in 1910 I[19] republished this in the form of a table with illustrative examples. These data, supplied so far as possible with metallurgical examples, are given in Table 1. In selecting the examples of the various classes no attempt has been made to distinguish between colloidal solutions and the coarser suspensions. It is obvious also that examples of all of these classes exist among the true solution, but they do not concern us here.

Of course the limit of colloidal complexity is not reached in the examples in the table. Only two substances are there considered, the particle and the medium. The medium is regarded as homogeneous, and all particles are assumed to be of the same substance. It is obviously possible to have more than one kind of particle or a medium which is itself complex, and it is not necessary that all of the particles be solid, or liquid or of any single state. A metallurgically important example of these complex conditions is the process of oil flotation, in which solid particles of several varieties (ore and gangue), liquid oil globules or oil films around the solid particles, an aqueous medium and in some cases bubbles of gas, all are present and active in determining the properties of the system. Still greater complexity is not uncommon.

A CLASSIFICATION OF COLLOIDS

	Solid Medium	Liquid Medium	Gaseous Medium
Solid Particle.	Many cryptocrystalline ores, especially those containing finely divided metals. Most solidified slags. Glazes, glasses, etc.	Ordinary suspensions and colloidal solutions of solid particles. Slimes, thickened or not. Wet plastic clays, etc. Turbidity in water. Deflocculated graphite, etc.	Fume and smoke. Flue dust. Dust of mines, flour mills, factories, etc. Systems involved in processes of air separation, etc.
Liquid Particle.	Liquid inclusions in crystals. Much occluded water and water of crystallization. Some filter cakes, etc., while wet.	Emulsions. Oil in condenser water and water in fuel oil. Oil-flotation systems. The glue-like organic colloids.	Fog, cloud and wet steam. Acid fume. Collection of acid from smelters, fertilizer works, etc. Oil sprays. Oil burners, etc.
Gaseous Particle.	Dry filter cakes. Silica brick and many other refractories. Mineral wool and metal sponge. Gas inclusions in crystals etc.	Foams and froths. Wet steam (phenomena of foaming in boilers). Systems used in gas and foam processes of ore separation.	No tangible examples.

Observations on Colloid Terminology

In conclusion of this introductory survey it may be useful to devote a paragraph to nomenclature. Colloid chemistry has developed a system of terminology of its own, and while it is not at all necessary to use this terminology in discussing the subject matter of the science, many of the terms are convenient and are now thoroughly engrafted on the literature. Most useful is the concept that regards the size of particle as due to the "degree of dispersion" of the particulate substance. A decreased size of particle is spoken of as a greater "dispersion" or the substance as more highly "dispersed." By extension all suspensions and colloids are "disperse" (or "dispersed") systems or "dispersoids"; the particles compose the "disperse" phase and the medium is the "dispersion medium." A true solution possesses a molecular or ionic degree of dispersion and is a "mol-" or "ion-dispersoid."[20] These terms include all colloidal systems, regardless of the solid, liquid or gaseous state of particle or medium. Colloidal solutions with a liquid medium are frequently referred to as "sols" (the oppositive term of "gel" will be discussed in a moment). If the medium is water, the colloid is a "hydrosol"; if alcohol, an "alcoholsol," or "alcosol," etc. By analogy with the systems of coarser particles the solid-particle sols are frequently called "suspensoids"; those of liquid particles, "emulsoids." The terms "sol," "suspensoid" and "emulsoid" with their compounds are properly applied only to systems within the assigned colloidal range of particle size. The adjectives "hydrophile" and "hydrophobe" are remnants of a terminology that is disappearing. They were supposed to refer to the affinity or lack of affinity of the substance for water. Roughly, they are equivalent to "emulsoid" and "suspensoid" respectively.

Much confusion has arisen from loose use of the terms "sol" and "gel" in metallurgical literature. As noted, a sol is a colloidal solution having a liquid medium and possessing the essential properties of liquids. It happens that some emulsoid colloids, of which gelatin is a good type, have the property of setting under certain conditions to form a more or less stiff jelly like table gelatin. These jellies are known as "gels." They have much importance in biology and some, perhaps, in the study of ore genesis, but it does not appear that they are important in metallurgy. They are produced only by the special colloids of the type mentioned, and gelatinization is not a general property of the colloidal state. The resemblance between a jelly-like thickened slime and a real gel is superficial only, and any consideration of this resemblance in metallurgical investigations is productive merely of confusion. A similar confusion has arisen through the use in this connection of the concepts of amorphous and crystalline and from the definition of colloidal substances as those which are not crystalline. It is open to question whether real amorphity exists except in fluids,[21] but this discussion would lead us too far into the minutiæ of modern theories of matter. For present purposes it is enough to recall that the particulate theory of colloids as we have developed it, includes no assumption as to the amorphous or crystalline nature of the particles, and it may safely be asserted that none is necessary. "Gel" and "sol" and "amorphous" in these senses could be well spared from metallurgical terminology.

The Bibliography of Colloids

The appended list gives a few of the more important general works on colloids. The books of Freundlich, Ostwald and Zsigmondy are the standard general treatises, but are devoted almost entirely to the purely scientific phases of the subject. None contains any important treatment of technical applications. Freundlich is particularly strong in citation of the original literature. Less complete but more clearly written are the works of Cassuto and of Taylor, the latter being the only adequate treatment of colloids in English. Although it, too, is confined to scientific rather than technical aspects, it is to be recommended to engineers interested in pursuing the subject. The small volume of Hatschek is an excellent and readable introduction, but carries few details. The work of Arndt is also introductory, is disappointingly barren of practical detail and cannot be recommended.

[19] Free, "Journ. Frank. Inst.," Vol. CLXIX, p. 424 (1910).

[20] This terminology is due to Wo. Ostwald, "Koll. Zeits.," Vol. I, pp. 291-300, 331-41 (1907); "Grundriss der Kolloidchemie," p. 83 (1909).

[21] See the papers of von Veimarn in the "Kolloid Zeitschrift," 1907 to 1909, republished as "Zür Lehre von den Zuständen der Materie" (1909). There is a brief summary by Johnstone and Adams in "Journ. Am. Chem. Soc.," Vol. XXXIII, pp. 837-40 (1911).

I am acquainted with no specific treatment of colloids as concerning metallurgy other than the papers of Ashley and Caetani cited below. There are many incidental notices in the textbooks of ore dressing and in special articles on the handling of slimes, some of which have been cited in the preceding pages.

Arndt, Kurt, "A Popular Treatise on the Colloids in the Industrial Arts." Translated by Nahum E. Katz. Easton, Penn., 1914. 60 pp.

Ashley, H. E., "Theory of the Settlement of Slime." "Min. and Sci. Press," Vol. XCVIII, pp. 831-2 (June 12, 1909).

Ashley, H. E., "The Chemical Control of Slimes." "Trans. A. I. M. E.," Vol. XLI, pp. 380-395 (1910).

Caetani, Gelasio, "Sand, Slime and Colloids in Ore Dressing." "Min. and Sci. Press," Vol. CVI, pp. 438-442 (Mar. 22, 1913).

Cassuto, L., "Der Kolloide Zustand der Materia." Leipzig, 1913. 252 pp.

Freundlich, Herbert, "Kapillarchemie." Leipzig, 1909. 565 pp.

Hatschek, Emil, "An Introduction to the Physics and Chemistry of Colloids." London and Philadelphia, 1913. 87 pp.

Ostwald, Wolfgang, "Grundriss der Kolloidchemie." Dresden, 1909. 509 pp. The first half of a second revised edition has been issued (1911, 329 pp.) and reprinted without change (1913) as the first half of a third edition. The second half has not been issued either in second or third editions.

Taylor, W. W., "The Chemistry of Colliods." London, 1915. 328 pp.

Zsigmondy, Richard, "Kolloidchemie." Leipzig, 1912. 281 pp.

Tungsten in South Africa

According to an article published in the *South African Mining Journal,* Dec. 11, 1915, the Department of Mines has been in communication with the Minister of Munitions, at London, who voices the fact that tungsten is urgently needed, that the ores—scheelite or wolframite—should contain not less than 70% of tungstic acid (WO_3) and that the price would be 55s. per unit, less 1% delivered at the warehouse in Liverpool or London.

Wolframite is found with the tin ore occurring at Kuils River, in the vicinity of the Cape Peninsula, but not in workable quantities. Scheelite is more widely distributed. Along the Southern tin belt from the Bush Tins, at Enkeldoorn, to Stavoren and Mutua Fides and beyond, scheelite has been found and often in quantities which, at present prices, should be payable. Its presence has also been noticed in the Rooiberg area and in the Oshoek and Swaziland tin fields. Some favorable specimens have also been found near Leydsdorp.

Since locally produced scheelite could not be finally dressed with the plant in possession of the owners, the Department of Mines inquired whether the Munitions Office would purchase concentrates and on what basis, asking for a scale of prices of varying percentages of tungstic acid, penalties for tin and charges for assaying, concentrating and smelting. A reply has been received asking for a sample of one ton of the concentrates, to be sent to London for experiment. No value can be given or scale fixed at the present time, since the concentrates are considerably below the required standard and contain a rather high percentage of tin and other impurities. A sample has been forwarded, and here the matter rests for the time being. It is of course impracticable for a mineral to be discovered, mined, concentrated and finally dressed to a high degree of purity at such a short notice as we have had with regard to this, but should it prove commercially profitably to export the hand-picked or roughly dressed scheelite for final treatment, a considerable quantity of ore may be expected to be discovered and exported.

Some exploration and mining have been done toward the production of molybdenite. With regard to this metal, the Mines Department is informed that its need by the Minister of Munitions is not great. The price quoted in market lists is extremely high, but the experiment of sending a consignment of three parcels from one of the tin mines resulted in great disappointment. In the first place, the assay of each parcel was returned as only about 50% of the value estimated in South Africa, and secondly, the other charges and deductions were so great that instead of bringing a profit, the shipment resulted in a net loss of £36.

Engineering Research Contemplated at Columbia

Dean Frederick A. Goetze and several members of the faculty of the Graduate Engineering School of Columbia University some time ago visited the research laboratories of the Reichsanstalt, at the Technische Hochschule at Charlottenburg, Germany. In Dean Goetze's annual report for 1915 he discusses a proposed plan to establish similar engineering-research laboratories for Columbia on a site easily accessible to the university, but with water and railroad facilities, which, with the necessary building and equipment, would cost $500,000. This would be but an initial step, as it is proposed that ultimately a research foundation of from $2,000,000 to $5,000,000 be secured, the income from which would be used exclusively for engineering research.

It is not understood that the project to establish the engineering-research laboratory is yet an assured fact, but comparing the cost of the proposed site and building for the laboratory with that planned for the next Applied Science building at Broadway and One Hundred and Sixteenth St., which would cost $500,000, Dean Goetze said:

"With the same amount of money we could buy a site with railroad and water facilities within five minutes' walk of the university, erect on it a building twice the size, of a modern factory construction much better suited to our purpose, and have about $150,000 left over for equipment. We should, however, make provision for extension and endowment as well, and from two to five millions of dollars will be needed for this purpose. It would not all be required at once, but in installments as the work developed and justified the expenditure. No other university is so favorably situated by its environment, prestige and traditions to lead in this important field, and we have at our door an opportunity such as has been presented to few engineering schools in this country. No greater or more enduring monument could be erected by the public-spirited persons who would equip and endow laboratories for this purpose.

Barium-Aluminum Glass

A new barium-aluminum glass has recently been invented by E. C. Sullivan and W. C. Taylor, assigned to the Corning Glass Works, Corning, N. Y. This glass is adapted to give air-tight points with metal wires, as it has a coefficient of linear expansion of more than 0.000012 and the requisite degree of fluidity when heated to a temperature of 640° C. It is composed of about 42% of silica, 19% of soda, 5% of potash, 19% of barium oxide and 16% of alumina, according to the *Journal* of the Society of Chemical Industry.

The Production of Tungsten Ores in the United States during 1915 broke the record and was apparently equivalent to about 2,165 short tons of concentrates, carrying 60% of tungsten trioxide (WO_3). This figure is based on preliminary returns to the United States Geological Survey. The largest previous output of tungsten ore was in 1910, when 1,821 tons was produced.

Comparative Efficiencies of Various Types of Air Compressors

SYNOPSIS—Efficiency of reciprocating compressors, 85 to 90%; of turbo-blowers, 75%; of positive or rotary blowers, 60 to 85%; and of hydraulic compressors, 82%.

In *Engineering News* of Nov. 4, 1915, in discussing air compressors for activated-sludge tanks, Carl H. Nordel, engineer of design of the Milwaukee Sewage Commission, gives the following summary of efficiency of various types of compressors for low- and medium-pressure services—such as are used in smelting and converting operations.

The mechanical efficiency of the reciprocating compressor, as ordinarily measured by comparing the work done in the steam and air cylinders, is usually in the neighborhood of 85 to 90%. The higher the pressures it is necessary to employ the more this figure will be reduced. The older types of compressors are less efficient than the later ones. The introduction of large thin-plate valves has reduced air velocity through ports and cut down the heating at this point. The higher the pressures the hotter are the cylinder walls—even with good cooling systems—and the greater is the reduction of air taken in for compression. Tests on plants in operation show that such losses in compression may perhaps be 25% (besides the 10 or 15% mechanical losses mentioned) for the higher pressures.

The first cost of reciprocating compressors is comparatively high, and they are bulky in proportion to their output. They may be had in any capacity from less than 100 cu.ft. per min. to the large blowing engines of from 40,000 to 50,000 cu.ft. per min.

Limitations of the Turbo-Blower

The turbo-blower is a comparatively recent development. It is substantially a turbine pump. The pressure is secured by imparting a high velocity to the air, with a subsequent transformation of the velocity head into pressure head. Water weighs about 800 times as much as air; hence to secure the same pressure rise per stage with a blower as with a pump, the velocity would have to be 28 times as great. In consequence the rotative speeds are usually carried as high as safety will permit. The impeller tips are sometimes run at 600 ft. per sec., when as much as 3 to 4 lb. pressure can be secured in a single stage. Ordinarily, however, 2½ lb. is considered the limiting pressure per stage.

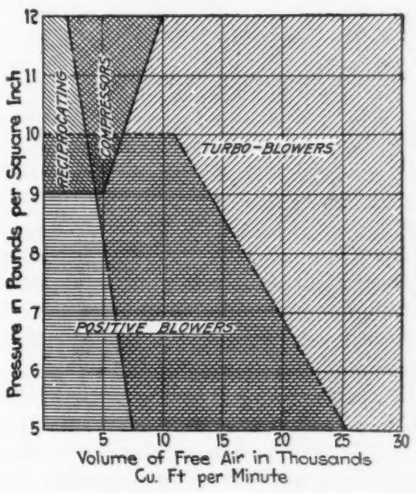
These blowers are well adapted to handling large volumes of air. Being high-speed machines, they are compact and comparatively inexpensive for their capacity. The larger units show a good efficiency, often reaching 75%; but the efficiency falls off with the size. Driven by direct-connected steam turbines, excellent overall economies are secured. The guaranteed steam consumption for units delivering in the neighborhood of 30,000 cu.ft. per min. is as low as 15½ lb. of steam per hour per air horsepower.

The steam-turbine-driven units have a flexible delivery, even at constant pressure, and by slightly varying the pressure high efficiencies over a large range of deliveries can be obtained.

A complete line of turbo-blowers direct-connected to high-speed motors and delivering from 2,000 to 40,000 cu.ft. per min. has been developed. Variable delivery at constant speed over a fair range, without too great loss in efficiency, can be secured by throttling the discharge and intake.

Positive-pressure blowers operate on the same principle as a rotary pump. Lobed impellers meshing with each other in a manner similar to the teeth of a gear revolve within a casing, sweeping the air before them. The impellers do not quite touch each other or the casing and there are consequently clearance spaces through which some of the compressed air leaks back. With well-made blowers the clearance is small and the leakage fairly low.

The amount of leakage is constant so far as the speed of the blower is concerned, but varies with the square root of the pressure. Hence these machines become less efficient as the pressure is increased, and this tends to limit their use generally to pressures below 10 lb. The leakage or slip is measured by the number of revolutions of the blower required to make it good. Thus, if the slip is 100 r.p.m. and the speed of the machine is 500, the volumetric efficiency is 400 r.p.m., or 80%. The capacity of the machine is usually stated in terms of the displacement per revolution, and the delivery is equal to the displacement multiplied by the rotative speed minus the slip. Obviously, the higher the speed the better is the efficiency.



FIELD FOR RECIPROCATING COMPRESSORS, TURBO-BLOWERS AND POSITIVE BLOWERS

The losses other than slippage are small. Probably 5 to 10% would cover all losses outside of slippage.

As the intake port is very large, the air is not heated on entering the blower, and thus a good volumetric efficiency is assured. Efficiencies based upon the power input range from 60 to 85%.

The positive-pressure blowers are comparatively slow-speed machines, ranging from 600 r.p.m. in the small sizes to 100 in the larger.

The positive-pressure blower is not well suited to a variable delivery, as the efficiency falls off with the speed.

There is another type of compressor that possesses peculiar interest—the hydraulic compressor, which has been so successfully installed in some mining districts.

This apparatus uses the weight of falling water to compress the air without the application of any intervening machinery. The water is allowed to fall through a shaft and in doing so sucks in air through a large number of small pipes and entrains it in small bubbles, which it carries to the bottom of the shaft. After descending far enough to secure the required pressure, the mixture of air and water is allowed to flow horizontally, whereupon the air separates out and fills a reservoir, from which it is drawn as needed. Excellent results have been obtained with several installations, notably at the Victoria mine, Michigan, and at Cobalt, Ont. The former compresses 36,000 cu.ft. per min. to 128-lb. pressure with an efficiency as high as 82%. This remarkable showing is explained in part by the fact that the compression is absolutely isothermal, the water absorbing the heat as rapidly as it is generated.

The diagram gives about the economical range for three types of blowers if the delivery is to be nearly constant, though such a diagram can naturally be only approximate.

Nordberg-G. E. Hoist for Elm Orlu Mining Co.

Probably one of the most interesting hoisting installations on the American Continent will be the new first-motion electric-driven hoist for the Elm Orlu Mining Co. at Butte, Mont. A number of distinct features in design and construction have been incorporated in the specifications for this equipment, and from an electrical point of view this installation will be the most powerful direct-current hoisting equipment in the United States. The mechanical part will be furnished by the Nordberg Manufacturing Co., Milwaukee, Wis., while the electrical equipment will be supplied by the General Electric Co., Schenectady, N. Y. This installation, when completed, will consist chiefly of a double-drum hoist, direct-current hoist motor, and a flywheel motor-generator set.

The hoist is to handle a load of 32,000 lb. on each side of a two-compartment shaft from an ultimate depth of 3,500 ft. The hoisting speed is to be 2,500 ft. per min., and following are the segregated loads:

	Lb.
Skip and cage	9,500
Ore	10,000
Rope (3,500 ft. of 1½ in)	12,500
Total	32,000

The contemplated hoisting cycle under which the hoist is expected to operate is as follows:

	Sec.
Acceleration	15
Full speed	77
Retardation	8
Rest	20

The hoist will normally operate in balance with the foregoing cycle, but the electrical equipment will be designed to handle the stated load out of balance with about 50% increase in hoisting time.

The mechanical part of the equipment will have two cylindrical drums 10 ft. in diameter with 96-in. winding faces. Each drum will be grooved and will wind the total rope in two layers. These drums will be constructed of 1⅜-in. rolled-steel plates, riveted to steel stiffening rings spaced equidistant along the total length of drum face. These shells will be supported at each end by steel end rings riveted to the shell and bolted to the spiders by ream bolts. The Nordberg company introduced drums of this construction for large hoists several years ago, and their operation, especially in the Butte district, has been watched with a great deal of interest. This type of drum is ideal for electric-hoist work because of its low weight and necessarily low moment of inertia.

The shaft and its flange coupling will be a solid forging and will be supported in three bearings. All of the bearings are to be of the ring-oiling two-part type, and each bearing will also carry sight-feed oilers working in connection with a gravity oiling system which supplies both the hoist and electrical equipment with lubricating oil.

The center bearing will permit of both vertical and lateral adjustment, and lateral adjustment will also be provided on both end bearings. All of the bearings will have removable shells; the bottom section is removable by rotating to a vertical position, after lifting the shaft slightly. The end bearings will be 16¾x36 in., and the center bearing will be 17x36 in.

Each drum will be loose on the shaft, and both will be equipped with powerful steel clutches of the Nordberg axial-plate type. Each drum will also carry a 14-ft. diameter by 18-in. face brake ring, and both will be provided with a set of post brakes. These post brakes are to be constructed of riveted rolled-steel shapes and plates and will be hung so as to compel parallel motion when engaging or releasing. These brakes will be applied by a dead weight and will be released by a single-acting thrust engine.

Engine-Operated Clutches

The clutches will also be operated by thrust engines, double-acting, and the medium used in these engines will be oil under pressure. Since its introduction by the Nordberg company a few years ago, oil-operated brakes and clutches have gained in favor. Oil, being a non-compressible fluid, makes a better medium than either air or steam, and as outside packed-plunger type engines are always used, the result is a speedy and reliable operation. All of these points were given great consideration in selecting the best system of brake application for this hoist.

Oil will be supplied to the brake-and-clutch engine by a motor-driven triplex pump working in connection with a direct-pressure loaded-plunger-type accumulator. Motors and pump will be in duplicate, only one set being necessary to supply the oil. One pump will run continuously, the amount of oil being regulated by a bypass valve. The size of the accumulator will be 16x48 in.

The operation of the brakes and clutches will be effected by balanced poppet-type valves operated through a system of floating levers. This arrangement compels the movement of the plungers in the thrust cylinder to follow the movement of the operator's handle, and the plunger is securely locked in any position that the operator cares to leave it.

The usual elevated operator's platform will be provided on which will be mounted the various levers for the control of the hoist. A lever for each clutch and one

for each brake will be provided, as well as the lever for the control of the hoist motor.

In addition to the geared miniature provided, there will be a marking band 6 in. wide on each drum to aid the operator in spotting at the landing mark. A runway from the operator's platform to the center bearing gives the operator ready access to these marking bands.

The driving motor for this hoist will consist of one General Electric type M.P.C. 16-pole 80-r.p.m. 550-volt shunt-wound direct-current motor of 1,800 hp. capacity. The shaft and flange coupling will be one forging, and the motor will be provided with two-pedestal-type ring-oiling bearings.

Power for this motor will be supplied by a flywheel motor-generator set. The alternating unit of the set will be a 14-pole 1,150-hp. 514 r.p.m. 2,200-volt 3-phase 60-cycle slip-ring-type induction motor, and the generating unit will be an M.C.F. type 12-pole 550-volt shunt-wound generator of 1,300-kw. capacity. The exciter for supplying the field current to the hoist motor and direct-current generator will also be mounted on the shaft of the motor-generator set.

In addition to the three electrical machines, the shaft of this motor-generator set will carry a steel-plate flywheel. This wheel will weigh approximately 92,000 lb., and the size will be 142 in. in diameter by 21 in. wide.

A slip regulator for limiting the power input to the set will of course be furnished, as well as a switchboard for the distribution and control of the electrical energy.

Safety Devices Prominent

The safety devices of an electrically driven hoist are always the most interesting part of the equipment, and the paramount idea in selecting the equipment for the Elm Orlu hoist was simplicity, yet perfect safety.

Overwind will be guarded against by cams driven from the hoist drums, which will automatically move the controller handle to the "off" position and slow down the hoist when either skip approaches the dump, in case the operator fails to do so, at the proper time. These same cams will also entirely shut off power from the hoist motor and make an automatic emergency application of the brakes in case the operator allows the skip to go past the dump.

In addition to the foregoing, small track-type limit switches, one for each shaft compartment, will be furnished, which will cut off power from the hoist motor and apply the brake. It is intended that these switches be located just above the point in the shaft where the slow-down cams would make the emergency application of the brake, so as to provide additional protection against overwind.

Welch stops will be provided, which will protect against overwind and will also apply the brakes and cut off power in case of overspeed.

There will be provided automatic-control features which will positively limit the rate of retardation to the minimum in which it is possible to retard the hoist without injury to the apparatus. The operator will of course be free to retard at a slower rate than that fixed by the automatic equipment and will also be free to run at intermediate speeds.

In case the main-line oil-switch opens owing to failure of power or overload, the brakes will not be applied nor will power be cut off from the hoist motor. The operator's attention will be called to this fact by a bell alarm, but he may continue hoisting by utilizing the stored energy of the flywheel.

Failure of exciter voltage or open motor field will automatically shut off power from the hoist motor and apply the brakes, and the same action results from the operation of the speed-limiting device on the shaft of the motor-generator set. A no-voltage relay will be provided which compels the operator to return the control lever to the off position, after an emergency shutdown, before starting hoisting again.

An emergency switch placed within easy reach of the operator will trip open the direct-current circuit-breaker, thus cutting off power from the hoist motor and applying the brakes.

This hoist will be the second equipment of this type to be installed in the Butte district, and its operation will undoubtedly attract a great deal of attention. The reputation of the two companies manufacturing the equipment is well known to mining men, and when completed, this hoist will be the finest and most complete installation of its kind in America.

Military Reading for Civilian Engineers

By authority of the Secretary of War and in response to frequent requests, the following suggested list of reading is issued by the War Department for the information of civilian engineers desiring to inform themselves on military subjects.

These references have been selected, first, with a view to giving to engineers unfamiliar with the art of war a general survey of that subject, an understanding of which is the first essential to insure successful application of engineering knowledge and resources to military purposes; and second, with a view to setting forth, as far as practicable, the ways in which engineering is applied to military purposes and the means provided therefor.

Both military art and military engineering are progressive, and a considerable part of the latest and most detailed information published is available only in service journals of our own and foreign armies. This is particularly true of technical details of seacoast defense (including submarine mining), of field artillery, of military aviation, and the influence of these on military engineering. It is believed, however, that the fundamentals of each subject are well covered by the references given in this list. While the list is long, the relative importance of the various works is indicated, and suitable comments on each are included, so that persons using the lists of references may be able to select those which particularly interest them.

The references under each subject are generally divided into two groups, the first containing the more essential references, and the second those suitable for persons desiring to inquire further into the subject.

Suggestions looking to improvements of the lists will be gladly received.

A. MILITARY POLICY, CONDUCT OF WAR AND MILITARY HISTORY

Group 1

1. OFFICIAL BULLETIN, Vol. 1, No. 2, Office of the Chief of Staff, Washington, D. C. (Especially pp. 21-39.) Publisher: Army War College, Washington, D. C. Free. (An official outline of the theory under which our forces are to be organized and administered.)

2. MILITARY POLICY OF THE UNITED STATES. Upton. May be obtained from Supt. of Docs.[1]; paper, 50c.; cloth, 65c. (A most valuable and comprehensive review of this subject.)

3. FIELD SERVICE REGULATIONS, 1914. May be obtained from Supt. of Docs.; 60c. (A condensed official statement of principles, methods and details of military operations.)

4. ELEMENTS OF STRATEGY. Fieberger, Publisher: U. S. Military Academy, West Point, N. Y. May be obtained from Book Dept.[1]; 75c. (A short outline, with historical illustrations.)

Group 2

5. CONDUCT OF WAR. Von der Goltz; translated by J. Dickman, Hudson Publishing Co., Kansas City, Mo. May be obtained from Book Dept.; $1.70. (The standard work on this subject, covering generally the same ground as 4, but more abstractly and elaborately.)

6. ON WAR. Clausewitz; translated by J. J. Graham; 3 vols.; K. Paul, Trench, Trubner and Co., 1908. May be obtained from Book Dept.; $6.60 (including postage and duty). (The greatest classic on the subject; a complete analysis of the phenomenon of war, and profound discussion of the mechanism thereof. Written early in the 19th Century, it is still the foundation of modern military theory.)

6½. THE NATION IN ARMS. Von der Goltz. May be obtained from Book Dept.; $2.50. (An excellent modern work on war; less elaborate but more readable than Clausewitz.)

7. AMERICAN CAMPAIGNS. M. F. Steele; 2 vols. Publishers: Byron S. Adams Publishing Co., Washington, D. C. May be obtained from Book Dept.; $4.50. (In addition to careful historical surveys of all the campaigns from the Colonial Wars to the Spanish American War, these lectures give extensive and valuable comments as to the military principles.)

8. A STUDY OF ATTACKS ON FORTIFIED HARBORS. Rodgers; Proceedings Nos. 111, 112 and 113, United States Naval Institute, Annapolis, Md.

9. LESSONS OF THE WAR WITH SPAIN. Mahan. Publishers: Little, Brown & Co., Boston, Mass. May be obtained from Book Dept.; $2. (Of special importance, as showing the true relation between our coast defense and our navy.)

10. REPORTS OF MILITARY OBSERVERS ON THE RUSSO-JAPANESE WAR. Part III, J. E. Kuhn. May be obtained from Supt. of Docs.; 60c. (In addition to an account of operations, this report contains valuable information as to fortification and siege work, organization and equipment.)

11. ORGANIZATION AND OPERATION OF THE LINES OF COMMUNICATION IN WAR. Furse, 1894. Publishers: Wm. Clowes & Sons, Ltd., London. (An old but comprehensive survey of this subject, with much historical information.)

B. PERMANENT FORTIFICATIONS

Group 1

(The references given cover chiefly the principles and general features of this subject; the details are mostly printed in unavailable form, either in service journals or in confidential documents. References to some of the former can be furnished, if desired.)

12. REPORT OF NATIONAL COAST DEFENSE. (Taft) Board, 1906. May be obtained from Army War College, Washington, D. C. Free. (The official project for harbor defenses of the United States. On account of progressive obsolescence of seacoast defenses, this project has been, or is being, modified, but still sets forth clearly the fundamentals.)

Group 2

13. LECTURES ON SEACOAST DEFENSE. Winslow. Publishers: United States Engineer School, Washington Barracks, D. C. Price, 50c. (Much of these lectures relates to technical details, and a considerable part is now obsolete.)

14. PERMANENT FORTIFICATIONS. Fieberger, 1900; United States Military Academy, West Point, N. Y.; $1. May be obtained from Book Dept. (While rather old, this work gives a simple presentation of the fundamentals on its subject, including an historical outline. A revised edition will soon be published.)

15. FORTIFICATIONS. C. S. Clarke. Dutton & Co., New York; $4.50. May be obtained from Book Dept. (A treatise on the same lines as 14.)

16. PRINCIPLES OF LAND DEFENSE. Thuillier, 1902; Longmans, Green & Co. May be obtained from Book Dept.; $3.83. (A valuable work, covering the principles of both field and permanent fortification.)

C. ORGANIZATION, EQUIPMENT AND DUTIES OF ENGINEER TROOPS

Group 1

17. FIELD SERVICE REGULATIONS, 1914. (See A. 3.)

18. TABLES OF ORGANIZATION, 1914. May be obtained from Supt. of Docs.; 25c. (These tables represent—subject to modification and within the limits of existing law—the approved policy of the War Department with regards to organization.)

19. OFFICIAL BULLETIN, Office of the Chief of Staff, Vol. 1, No. 4 (Appendix 4). Use of Engineer Troops. Publisher: Army War College, Washington, D. C. Free. (An official statement of the principles which should govern in the use of engineers, with practical suggestions.)

20. DUTIES OF ENGINEER TROOPS IN A GENERAL ENGAGEMENT OF A MIXED FORCE. Burgess. Publisher: United States Engineer School, Washington Barracks, D. C.; 25c. (Obsolete in some respects, particularly organization, but excellent in general scope.)

21. GENERAL ORDERS NO. 6, WAR DEPARTMENT, 1915. May be obtained from the Adjutant General, United States Army, Washington, D. C. Free. (Prescribes the training of Engineer troops.)

[1]The following abbreviations are used: Supt. of Docs., Superintendent of Documents, Government Printing Office, Washington, D. C. Book Dept., Book Department, Army Service Schools, Fort Leavenworth, Kan.

Group 2

22. STUDIES IN MINOR TACTICS. Army Service Schools, 1915. May be obtained from Book Dept.; 50c. (The principles of Minor Tactics are set forth by solution of a series of problems.)

23. TECHNIQUE OF MODERN TACTICS. Bond & McDonough, 1914; Banta Publishing Co., Menasha, Wis. May be obtained from Book Dept.; $2.55. (This work covers, in a very specific way, the principles of tactics for all arms, a general knowledge of which is essential for engineers.)

24. OPERATION ORDERS. Von Kiesling; translation. May be obtained from Book Dept.; 50c. (A lucid exposition, by use of assumed cases, of the operation of highly trained troops of all arms in various phases of battle.)

25. ENGINEER UNIT ACCOUNTABILITY MANUAL. May be obtained from Supt. of Docs; 5c. (Official lists of standard equipment supplied to Engineer battalions and companies.)

26. ORGANIZATION OF THE BRIDGE EQUIPAGE OF THE UNITED STATES ARMY, 1915. (Revised edition just going to press.) (Includes description of equipage and regulations for ponton drill.)

27. OFFICERS' MANUAL. Moss; Banta Publishing Co., Menasha, Wis.; $2.50. May be obtained from Book Dept. (Treats of routine duties of officers, customs of the service, army organization, etc.)

28. MANUAL FOR COURTS MARTIAL. May be obtained from Supt. of Docs.; 50c.

D. FIELD ENGINEERING

(Military field engineering at the front differs from ordinary engineering work in the field, it being generally simpler, of a rough-and-ready character, and especially because of the limited equipment which can be taken along with the advance of an army and because of the necessity of working in strict subordination to the military situation. In rear of the army on the contrary, conditions are very similar to those governing ordinary engineering operations, and civilian organization is suitable, subject to directions by the higher military staff. Little attempt is made in works on military field engineering to treat of general engineering methods.)

29. FIELD FORTIFICATION. Fieberger, 1913; John Wiley & Sons, New York. May be obtained from Book Dept.; $1.90. (In addition to technical details, this work gives valuable historical illustrations of the principles of this subject.)

30. FIELD ENTRENCHMENTS, SPARE WORK FOR RIFLEMEN. John Murray, London. May be obtained from Book Dept.; 40c. (A very uptodate little work, especially on details.)

31. NOTES ON FIELD FORTIFICATION. Army Field Engineer School. May be obtained from Book Dept.; 30c.

32. ENGINEER FIELD MANUAL. Professional Paper No. 29, Corps of Engineers, United States Army; 3d edition, 1909. 500 pages. May be obtained from Supt. of Docs.; $1. (A very complete official pocketbook for engineer officers in the field, containing much tabular and technical data, as well as brief outlines of principles and methods. The subjects covered are, Part I, Reconnaissance; Part II, Bridges; Part III, Roads; Part IV, Railroads; Part V, Field Fortification; and Part VI, Animal Transportation. A new revision of the manual is contemplated, but will not be ready within a year. The portion of the manual relating to field fortification, being somewhat obsolete, should be considered in connection with either 30 or 31 above. The portion relating to railroads is largely superseded by 35 below.

33. NOTES ON BRIDGES AND BRIDGING. Spalding. May be obtained from Book Dept. (A small pamphlet on military bridging.)

34. MILITARY TOPOGRAPHY FOR MOBILE FORCES. Sherrill, 2d edition; Banta Publishing Co., Menasha, Wis., 1911. May be obtained from Book Dept.; $2.25. (Besides matter given in ordinary textbooks on surveying, this work gives in detail the special methods of sketching developed in the army for rapid military mapping.)

35. MILITARY RAILROADS. Connor; Professional Paper No. 32, Corps of Engineers, United States Army. Supt. of Docs.; 50c. (Intended to cover general administration of existing railroads for military purposes and the handling of railroads by military personnel in the advance sections where railroads cannot be operated by their regular civilian organizations, or where new railroads are required in the immediate vicinity of the army. Revised edition soon to appear.)

36. NOTES ON MILITARY EXPLOSIVES. Weaver; J. Wiley & Sons, New York; 1912. May be obtained from Book Dept.; $2.20. (Elementary notes on this subject will be found in the Engineer Field Manual and other references cited. This work is more elaborate.)

E. MISCELLANEOUS

37. REGULATIONS FOR THE ARMY OF THE UNITED STATES. Supt. of Docs.; 50c.

38. THE "VOLUNTEER LAW," approved Apr. 25, 1914; Bulletin No. 17. War Department, 1914. May be obtained from The Adjutant General, United States Army, Washington, D. C. Free.

39. GENERAL ORDERS NO. 54, War Department, 1914. May be obtained from The Adjutant General, United States Army, Washington, D. C. Free. (Covers examination of candidates for commissions as officers of volunteers.)

40. General Orders No. 50, War Department, 1915. May be obtained from The Adjutant General, United States Army, Washington, D. C. Free. (Amends General Orders 54, 1914, as to examination of candidates for commissions in volunteer engineers.)

41. TREATISE ON MILITARY LAW. Davis; J. Wiley & Sons, New York. May be obtained from Book Dept.; $5.30.

42. ELEMENTS OF MILITARY HYGIENE. Ashburne; new edition; Houghton, Mifflin & Co., Boston, 1915. May be obtained from Book Dept.; $1.30.

F. PERIODICALS

43. PROFESSIONAL MEMOIRS. Corps of Engineers, United States Army, and Engineer Department at Large; bi-monthly (formerly quarterly); Washington Barracks, D. C., Engineer Press; per year, $3.

44. THE ROYAL ENGINEERS' JOURNAL. Royal Engineers Institute, Chatham, England; monthly; per year, $4. (American agents: E. Steiger & Co., 49 Murray St., New York.)

45. JOURNAL OF THE MILITARY SERVICE INSTITUTION. Governors Island, New York. Bi-monthly; published by the Institution; per year, $3.

46. JOURNAL OF THE UNITED STATES ARTILLERY. Bi-monthly; Fort Monroe, Va., Coast Artillery School press; per year, $2.75, including Index to Current Literature; without Index, $2.50.

47. JOURNAL OF THE UNITED STATES CAVALRY ASSOCIATION. Published by the Association at Fort Leavenworth, Kan.; per year, $2.50.

48. INFANTRY JOURNAL. Bi-monthly; published by the United States Infantry Association, Union Trust Building, Washington, D. C.; per year, $3

49. FIELD ARTILLERY JOURNAL, quarterly; published by the United States Field Artillery Association, 601 Star Building, Washington, D. C.; per year, $3.

Mining at Tocopilla, Chile

SPECIAL CORRESPONDENCE

Tocopilla, Chile, has lately been in the limelight as the site of the power plant for the great copper enterprise of the Chile Exploration Co. at Chuquicamata. In the latter half of the Nineteenth Century, however, Tocopilla was itself a copper port and mining center of considerable importance. At one time there were eight large mines in exploitation by British companies, and there were four smelting establishments prior to 1885 when, with the decline in the price of copper, most of the English companies shut down. Since then mining in the Tocopilla district has been spasmodic—not so much for want of mines as for lack of good management.

In 1903 and 1904 the mining and shipping establishments of Bellavista and Buenavista were acquired by the H. B. Sloman Nitrate Co. and the Anglo-Chilean Nitrate and Railway Co. Both companies pulled down the smelting furnaces and converted the establishments into nitrate shipping plants, building two moles for loading and discharging. The mines belonging to both establishments were acquired by the Sociedad Beneficiadora de Tocopilla in 1906, but like many of the later attempts, this enterprise was foredoomed to failure by inexperienced management. Under competent management the enterprise might be converted into a success.

The principal mines that have been worked in the Tocopilla district are within a radius of about five miles from the old smelting plants. From the deck of a steamer in the bay, one can see the following mines, beginning from the town: Buenavista, with a shaft 420 m. deep; Argentina, with both shaft and tunnel; Santa Maria, also with shaft and tunnel; Feliciana, with a 300-m. shaft; Percance, with a 220-m. shaft; Portezuela, with shaft 180 m. deep; and Colorado, with a 200-m. shaft. Invisible from the deck of the steamer, but in this same district, are: Santa Rosa, famous for its fine atacamite; Rosario, with a shaft 200 m. deep; Carmelita, with 380-m. shaft; San Roque, with 300-m. shaft; Despreciada, with 240-m. shaft; Deseada, with 280-m. shaft; San José, with two tunnels and shaft; Crimea, with similar workings. The Fortuna, Teresa and a few others are in this district, adjacent to the seashore. At a distance of about seven miles from the shore the Santa Cruz has been worked to a depth of about 140 m., and farther east, about 11 mi. from the coast, is the Oropesa group, open to 215 m. and now being worked on tribute.

All of these mines are in the Coast range, which is about 12 mi. broad and at several places projects into the sea. Some of these mountains rise to nearly 7,000 ft., but most of them are between 3,000 and 5,000 ft. The range starts at Arica and runs continuously south to Mejillones, with only two breaks—the Loa River and the Duendes gully of Tocopilla. The latter has been the only route for horse-drawn vehicles from the coast to the Bolivian highlands. The mouth of the Loa is about 30 mi. north of Tocopilla, where it runs nearly due west and empties into the sea at the easternmost point of the Pacific Ocean. About 38 mi. east of Tocopilla the river runs north through the Toco nitrate fields, after having come westerly from the direction of Chuquicamata. At Toco the river is 3,525 ft. above the sea, and north of Toco two power dams have been built by nitrate companies. North of Tocopilla the river is capable of delivering 10,000 hp. and a project has been under consideration to build a dam and supply power to mines in the vicinity of Tocopilla.

About eight miles north of Puntillas station, on the Anglo-Chilean Nitrate R.R., there is the Descubridora mine, which has been worked on a small scale for a number of years, shipping 15% copper ores carrying some gold and silver. On the western slope of the range there was an old silver-lead mine which formerly shipped to Antofagasta ore carrying about 45% lead and 20 oz. of silver. There are several iron and manganese deposits in this region north of the railway, but under the circumstances they have no value. To the south of Tocopilla there have been numerous mines worked in the Coast range, but many of the old mines are now idle. The San Lorenzo was worked by shaft and tunnel. Farther south the Buena Esperanza, prior to the tidal wave of 1877, sent its ore by aërial tramway to Punta Blanca, where it was crushed and concentrated to about 24% and shipped direct to England. A little farther south the Chancaca group formerly shipped high-grade chalcopyrite and bornite. To the south of this the *mantos* begin and continue to Huanillos, where the San Roman, Bandurria and Guadalupe have been famous mines. South of these is the Gatico group, of which the Toldo is the most important. This company has increased its activity and is buying ores from some of the mines in the vicinity of Tocopilla. The custom-house records show the shipments from Tocopilla of 6,200 tons of raw ore having a tenor of over 14% copper, during the first 10 months of 1915. Much of this ore was shipped to the Gatico company. Among the shipping mines to the southeast of Tocopilla are the Tres Puntas, Nueva Duendes and San Juan. The Gatico smelting plant is about 25 mi. south of Tocopilla.

Leading Zinc-Mining Centers in the United States

On page 63 of the *Journal* of Jan. 8, 1916, the map of zinc-mining and zinc-smelting centers in the United States showed only one important zinc producer in California—the Cerro Gordo Mining Co., near Keeler, in Inyo County. A reader calls attention, however, to a much larger shipper of zinc, namely, the Mammoth Copper Mining Co., of Kennett, Shasta County. This company had a zinc-sorting plant continuously in operation during 1915 and shipped ore carrying nearly 7,000,000 lb. of zinc.

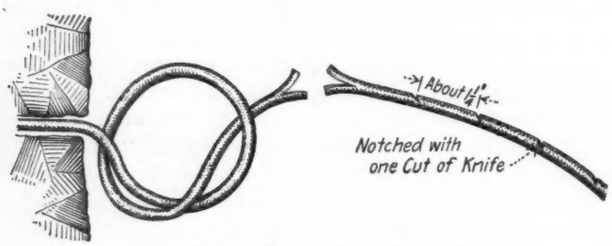
Details of Practical Mining

Proper Way To Spit Fuses

By Percy E. Barbour*

Much has been written on various schemes for aids in spitting a round of holes. In my opinion there is only one proper way to spit a round of holes in the ordinary drift or tunnel heading or stope, where from 10 to 20 holes are to be fired in one round. More than 20 fuses can rarely be spit with satisfactory results, because by the time one gets to the last fuses the heading is so filled with smoke that the chances are very much against being able to see all that remain to be spit.

After the holes have been properly loaded and tamped, the fuses, which were originally cut all the same length, are shortened to secure proper sequence in firing, as follows: The holes that are desired to fire last have an inch or two of fuse cut off in order to remove any dampened powder train; these fuses are then coiled up loosely and the end pulled through the loop in order to form a loose knot and leave the end of the fuse sticking out convenient to be reached. The fuses that are in the holes that are



NOTCHED-FUSE FUSE-SPITTER

desired to go next to last are then cut, removing a piece an inch or inch and a half longer than the piece removed from the previous hole. In this way all of the fuses are shortened, using the piece of fuse cut from the previous hole as a measure of the amount to cut off until the final cut holes are reached. Then the ends of all the fuses are split for about ⅜ in., as shown in the cut.

Then a piece of fuse half as long as the shortest fuse to be fired is notched as shown in the illustration; the end is then spit and with this spitter in the right hand, the left hand picks up the fuses one after another, holding the fuse and the spitter together. As the fire spits from each notch in the spitter, it is directed against the split end of a fuse in the face.

This spitter will not go out and cannot be blown out by the fuses, as is sure to frequently happen when using a candle flame or an acetylene lamp for this purpose. The reason for making the spitter one-half the length of the shortest fuse is to give a gage of the time after the the first fuse was lighted, so that the miner will know positively that he has plenty of time left in order to get safely away from the face, which he is not sure of in case he uses candles or matches for spitting and has a little delay, due to a blown-out flame, or a cloud of smoke, or other causes.

There have been a great many schemes suggested for spitting fuses, such as using a red-hot iron heated in a blacksmith's forge—which is a very long way from the heading of an average mine drift—holding the fuses in a split stick and firing them all with a torch, notching the end of a fuse and putting a pinch of dynamite therein and then setting fire to the dynamite. The notched-fuse fuse-spitter is an old practical miner's kink and there is no other method quite so good.

*Editorial staff, "Engineering and Mining Journal."

Bypass Around Leaky Tunnel in Catskill Aqueduct*

Driving a shaft and tunnel supplementary to the Moodna pressure tunnel, which connects with the Catskill Aqueduct tunnel under the Hudson River at Cornwall, N. Y., to stop leakage from a damaged section, is practically the last chapter of the gigantic water-supply project of New York City.

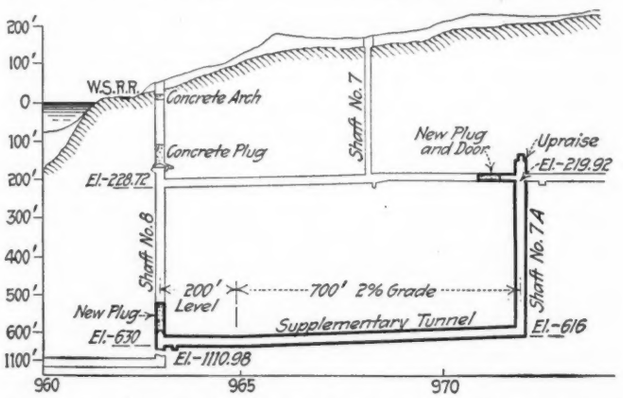


FIG. 1. PROFILE OF OLD AND NEW TUNNEL SECTION

The original work was carried on through two shafts, known as No. 7 and No. 8, shown in the profile, Fig. 1. No. 8 shaft formed the connection between the siphon under the river and the main water-supply tunnel and had been permanently sealed. No. 7 shaft was driven as an access shaft and was left open to permit operation of the aqueduct. The cracks which developed in the old tunnel are located near Shaft 8 and extend part way toward Shaft. 7.

When it was decided to replace the damaged section the plan adopted was to drive a new tunnel section parallel to the old, but located 400 ft. below it. To save time and expense the contractor was required to utilize Shaft 7 (8 ft. 8 in. in diameter) for handling all materials. This necessitated sinking a supplementary shaft (designated No. 7A), 17 ft. in diameter and 400 ft. deep, from a point within the old tunnel and driving a new tunnel 17 ft. in diameter and 900 ft. long. The latter formed the

*By Charles A. Hirschberg in "Engineering News," Dec. 9, 1915.

new connection between the siphon and the main water tunnel. A concrete lining reduced both shaft and tunnel to approximately 14 ft. 2 in. in diameter.

It was at first thought feasible also to utilize Shaft 8 for handling materials directly from the new tunnel to the surface. This shaft, however, had been sealed at the top by a concrete dome and also by a concrete plug 50 ft. thick and 30 ft. above the old tunnel, so that the idea of using this shaft was abandoned. Blasting operations for the removal of the 50-ft. plug would have endangered the shaft lining. The concrete dome, however, was removed, and the novel idea was conceived of utilizing the portion of Shaft 8 between the new and old tunnel levels by drilling two 8-in. holes through the plug with a core drill. One hole was used for passing the hoist cable from the surface for handling a cage and the other for chuting concrete for the tunnel and shaft lining. The tunnel work was prosecuted entirely from Shaft 8.

Work in the raise above the proposed No. 7A shaft was necessarily slow because of its large size and the need for continual building of temporary staging, which had

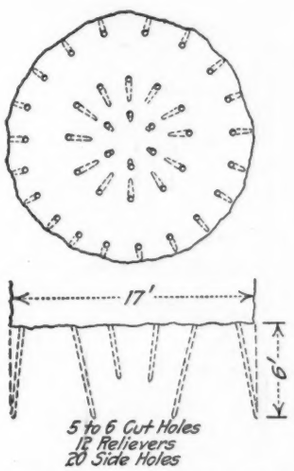


FIG. 2. DRILLING DIAGRAM FOR SHAFT ROUND

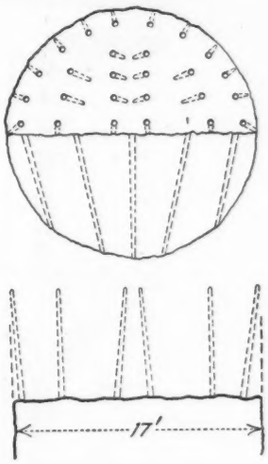


FIG. 3. DRILLING DIAGRAM FOR TUNNEL ROUND

to be torn out prior to blasting each round. Work was started on Dec. 31, 1914, and was completed Jan. 17, 1915. Three stope drills were employed for the drilling. The dome was concreted to form a setting for the hoisting headframe with its sheaves and to eliminate danger incident to rock sloughing off.

In Fig. 2 is a diagram of the drilling round in the shaft. This round consisted approximately of 38 holes. For drilling the shaft as many as six heavy "Jackhamers," Bull Moose size, were employed at one time. The day was divided into one 8-hr. drilling shift and two 8-hr. mucking shifts. All holes were started 2 in. and bottomed 1⅝ in. for 1¼ in. powder. The entire sinking of 400 ft. was completed in 76 rounds, giving an average advance per round of 5.26 ft. In portions of the shaft it was necessary to employ temporary steel lining.

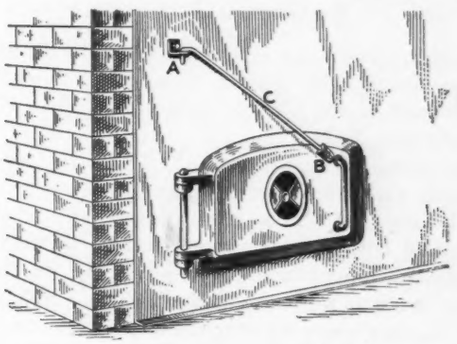
All hoisting in Shaft 7A was handled by bucket, except in the case of the spoil, when the transferable bodies of the 2-ton steel cars were used.

The supplementary tunnel, 17 ft. in diameter and 900 ft. long, was driven by the usual heading-and-bench method. The round (in Fig. 3) consisted of 26 to 28 holes in the heading and five holes in the bench.

Work in the tunnel was started from a platform placed in Shaft 8. The first round was blasted on Feb. 6 and holed through on May 20, during which time 206 rounds were drilled, blasted and mucked, giving an average advance of 4.37 ft. per round. The drilling and mucking may be said to have proceeded simultaneously. The first drilling crew worked from 8 a.m. to 4 p.m. and the second from 8 p.m. to 4 a.m., while the first and second mucking crews worked from 4 p.m. to 12 midnight and from 4 a.m. to 12 noon. Holes in the heading averaged from 7 to 8 ft. deep, and from 6 to 8 ft. deep in the bench. All holes were started 2 in. and bottomed 1⅝ in. Changes of steel averaged 24 in. Four No. 18 Leyner-Ingersoll water drills on two columns were employed in drilling the heading. Two drills of the same type set up on tripods drilled the bench. Each machine was manned by two men. About 150 lb. of 1¼-in. gelatin was consumed per blast in the tunnel and 90 to 100 lb. in the shaft.

Old Fire-Doors Made Usable*

Fire-doors are difficult to keep closed tightly when the holes in the hinges become worn and allow the opposite end of the door to sag. Sometimes, larger holes are drilled in the hinges and, by inserting larger pins or



SUPPORT FOR SAGGING FIRE-DOOR

bushings, the old doors are brought back to their original position, but this will not be permanent.

A simple method that any engineer can apply is shown in the illustration. An angle iron *A* should be fastened to the furnace front about 12 in. above the door hinge; another angle iron *B* should be fastened to the fire-door and the rod *C* inserted and secured by tightening the first nut enough to lift the door to the right position; then the second nut can be tightened to lock it.

New Method of Stripping on the Mesabi

For the first time, says *Excavating Engineer*, the method of stripping the overburden from coal deposits by the use of a large revolving shovel, a method which has proved such an unqualified success in the Kansas district and elsewhere, has been applied on the Mesabi iron range. Butler Bros., who were the first to use heavy shovel equipment of the standard railway type on the range, are employing the new method on the Mace No. 2 mine, at Nashwauk, Minn.

*By C. E. Kling, Philadelphia, Penn., in "Power," Dec. 28, 1915.

The shovel is a 225-B Bucyrus, weighing about 320 tons in working condition. It is equipped with an 80-ft. boom and a dipper handle 58 ft. in length, allowing it to cut a level floor 128 ft. in width and reach 61 ft. in height measuring from the open dipper door.

The shovel is taking the entire depth of the stripping in one cut. This naturally eliminates a large track gang and makes it worth while to lay the dump-train track with greater care, as it is not necessary to shift so frequently. The shovel, furthermore, moves up but once in 6 or 7 hours. The entire operation is managed by four men on the shovel—an engineer, a craneman, a fireman and an oiler—and two pitmen.

One interesting problem was evolving a simple method of bringing coal to the shovel. The coal is placed in boxes holding about two tons each, which are brought up to the job on the dump cars. Wire cables are attached to these boxes in such a manner that the cables may be thrown over the shovel's dipper lip. In this manner the box can be lifted from the dump car and placed in the cut with little delay or trouble.

Dropping Ore Through a 1,135-Ft. Raise

By Carroll M. Carter*

Dropping ore down a long raise results in many difficult problems. To obviate these the following method was devised at the Carter Mining Co., Ohio City, Gunnison County, Colo.

Our raise is 4-compartment, 1,135 ft. high, driven vertically through the granite, and connects with a shaft 240 ft. deep. The raise has 11 levels, and when driving it we used both outside compartments for waste and we kept these compartments full—drawing at the bottom only as much as we broke at the top. A bulkhead of very heavy timbers was used over the two center compartments —the cageway and ladderway. Right under the bulkhead we kept an opening into each outside compartment. When we were ready to shoot, or rather, were getting the round drilled, the waste in both outside compartments was drawn down enough to provide room for the rock to be broken. After the round was shot, the men could immediately get up above the bulkhead through one or the other of the openings under it. On every level we had a gate in each of the outside compartments so that a man could start drawing dirt at one gate, letting the dirt into the next compartment below, and go on up, drawing at every level, and in less than an hour reach the top. The broken granite ran satisfactorily all the time.

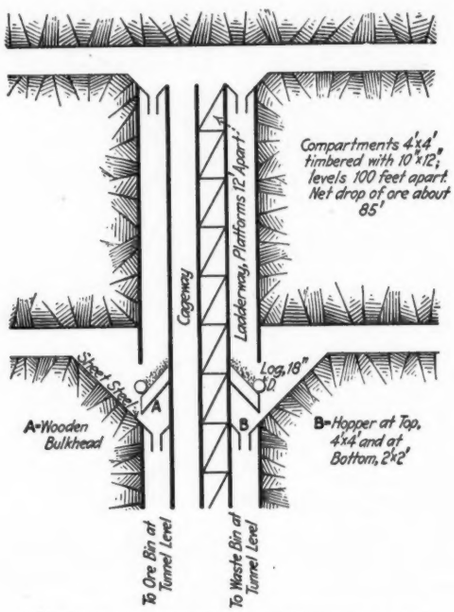
However, when the raise was completed and we began mining ore, it was found that the waste and ore compartments could not be kept full; the ore was sticky and would not run; and there was some trouble even with the waste hanging up somewhere in the compartment and then letting go suddenly.

We therefore figured on a counterbalance system of lowering the ore, but abandoned it after the present system was thought of which cost for installation about one-twelfth of what the counterbalance installation would have cost. Moreover, the present system permits of dumping either ore or waste at any level at any time without any waiting for a skip.

*1430 Vine St., Denver, Colo.

We already had heavy bulkheads at every level, with pockets for the dirt to run into before going into the compartment below. At the lower ends of these bulkheads we put in logs 18 in. diameter, and in each compartment at every level hoppers of ¼-in. steel plate were placed, and the outside compartments were of course emptied from top to bottom.

The outside compartments are 4x4 ft. in the clear, and the hoppers were made to converge to a hole 2x2 ft. By experiment we had determined that ore or waste going through a hole this size would not spread enough, in dropping 100 ft., to dig into the lagging on sides of the compartment; as a matter of fact the net drop is only 85 ft. The ore lands on itself—the pile kept at bottom of each compartment by the 18-in. logs—rolls out into the pockets, then into the hoppers and so on down to the ore or waste bin at the bottom or tunnel level. A car of ore or waste dumped in at the top level is in the ore bin, 1,135 ft. below, in a minute or two and no power or


Compartments 4'x4' timbered with 10"x12"; levels 100 feet apart Net drop of ore about 85'
Cageway
Ladderway, Platforms 12' Apart
Log, 18"
A-Wooden Bulkhead
B-Hopper at Top, 4'x4' and at Bottom, 2'x2'
To Ore Bin at Tunnel Level
To Waste Bin at Tunnel Level

VERTICAL SECTION THROUGH RAISE

attendance is required. The steel hoppers have been in use over a year, and none of them shows appreciable wear.

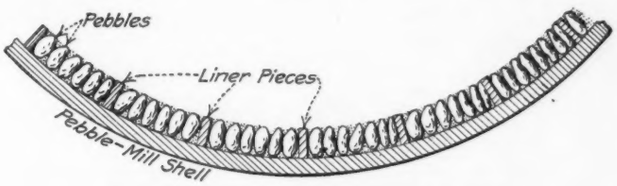
In the old mine, above the top level of the raise, we have put chutes so that ore is led direct to the main raise and down to tunnel level without rehandling. The accompanying sketch shows the arrangement of pocket, bulkhead and hopper at each level—all are the same.

This plan may have been used elsewhere, but it was original with us and was developed after experiments showing how much our ore would spread in dropping from one level to another. The spread is surprisingly small. If a man happens to be on one level when a car of ore is dumped into the ore pocket on the level above, he hears the ore going through the hopper, but does not hear another sound until the ore hits the pile in the compartment on the level where he is standing. The ore goes on through, and again there is silence until it hits 100 ft. below. A careful examination of the inside 3-in. lagging shows that the wear and tear on it is next to nothing. The method has therefore proved perfectly satisfactory both as regards operation and cost of maintanence and repair.

Details of Milling and Smelting

Plymouth Lining for Tube Mills

A method has been devised by the operators at the mill of the Plymouth Con. Gold Mines Co., Plymouth, Calif., to utilize the worn parts of semi-steel battery-liner plates. The plates were broken into pieces roughly 4 in. wide and 12 to 36 in. long. These pieces were set in cement with the pebbles, the liner pieces being set lengthwise of the mill and from 8 to 12 in. apart. They were, on the whole, about flush with the pebbles, though some



A PEBBLE LINING FOR TUBE MILLS

points projected as much as ¾ in. above the general pebble surface.

The lining as described, and as shown in the accompanying sketch, was installed in an 8-ft. by 22-in. Hardinge pebble mill and has every appearance of wearing well, although it has not been in use long enough to wear it out.

Keeping Crawling Insects Out of Quarters

In the erection of the frame quarters at the Darien, Canal Zone, radio station and of quarters transferred to Ancon, as well as some of the new buildings erected at Corozal for the army forces, special care has been taken to insulate the interiors against the access of ants and other crawling insects so numerous on the Isthmus, says the *Canal Record*. The walls of the buildings were supported on short wooden columns resting on concrete footings, into each of which was built a cup, or gutter, 2 in. wide and 1½ in. deep, surrounding the entire block. The cups are to be kept filled with larvacide, and those on the outside footings are protected by a small projection of concrete, like a pent roof, to keep out the heavy, driving rains which frequently occur. Small metallic cups were installed on the pipes and wires running into the house; these were brought into the house vertically from beneath, and the cups affixed in a horizontal plane.

The arrangement has so far proved fairly effective where the cups are kept filled with larvacide and vegetation is not allowed to grow against the house. One company of wood ants gained entrance to one of the buildings at Darien, but it was found that they had come in by means of a clump of grass, which, waving back and forth in the breeze, touched intermittently against the lower edge of one of the walls. When the grass was cut down, the ants already in the building, finding their line of communication broken, returned to the spot and dropped to the ground. Other wood ants, however, having gained entrance, have propagated inside, living in the wood. No other crawling insects give any trouble.

Australian Filter Practice

At the plant of the Sons of Gwalia, in Western Australia, the filter plant has exceptionally high efficiency, as described by T. B. Stevens, in the *Monthly Journal* of the Chamber of Mines of Western Australia, Sept. 30, 1915. Using a vacuum of 27 in. and a pulp containing 40% solids, a cake 3 in. thick and containing 28% moisture and 20.5 lb. of dry slime per sq.ft. can be obtained in a little over 20 min., while a further 60 min. suffices for applying a separate wash of spent solution and fresh water. This is accomplished because of the extreme porosity of the pulp. The filter is of the standard leaf-vacuum type.

In order to allow the large amount of solution to flow freely between the cloths, it was necessary to increase the space between them beyond that provided by the coco matting, and this is done by using wooden spacing sticks as well as the mat. A further modification is required because of the heavy cakes, for it was found that the porous cakes dried rapidly during transfer of washes and cracks formed readily and pieces of the cake fell off. The difficulty was overcome by the use of sprays to keep the cake damp.

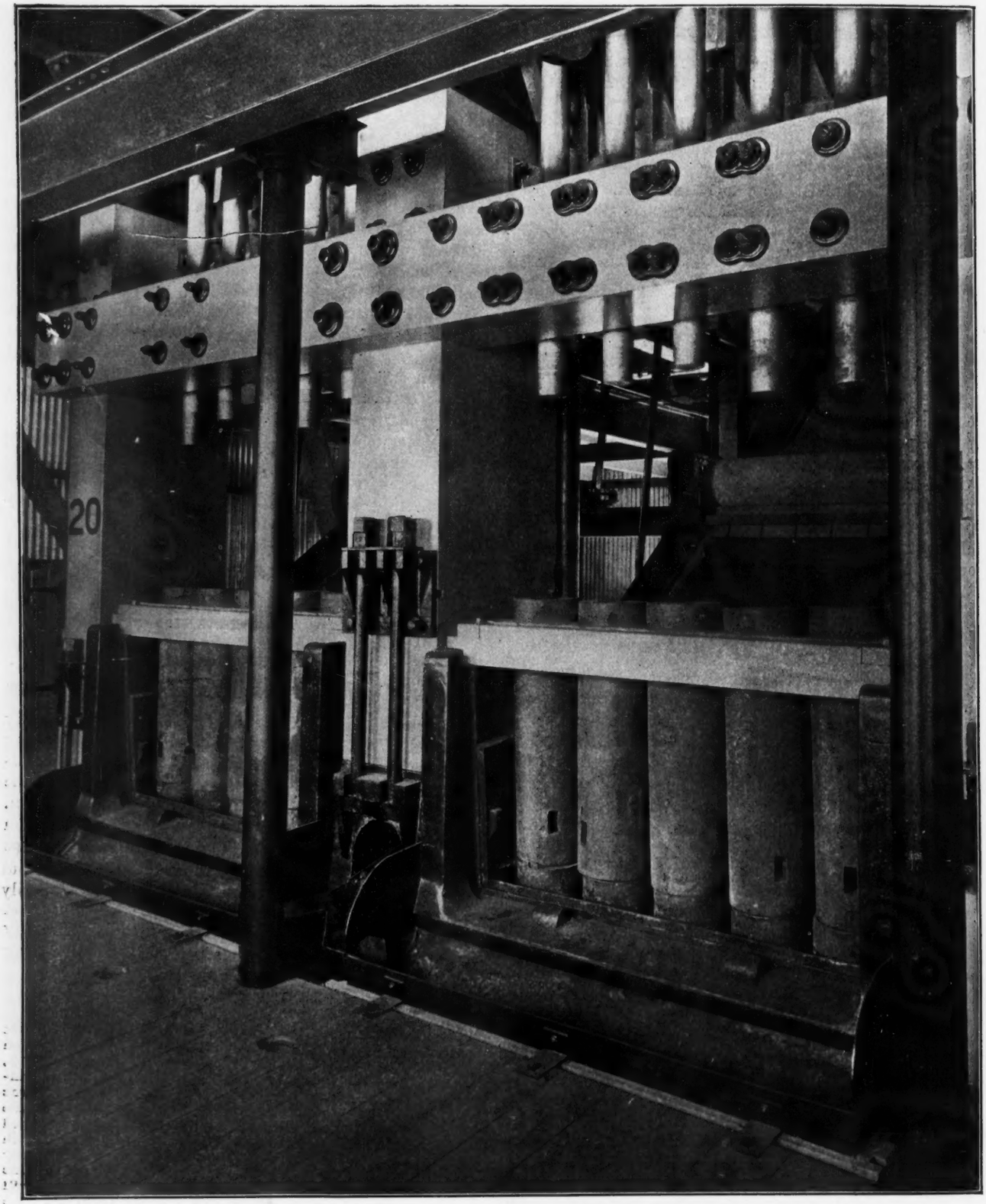
Hall Method of Zinc Electrolysis

Clarence A. Hall, of Mount Airy, Penn., has recently patented (U. S. Pat. 1,163,911) a method of maintaining the free ion concentration while electrolyzing zinc sulphate or chloride. This consists in suspending in the electrolyte calcium carbonate in finely divided form. The carbonate is decomposed by the anion, giving calcium sulphate (insoluble) or chloride (soluble), so that the zinc is deposited in coherent form on the cathode.

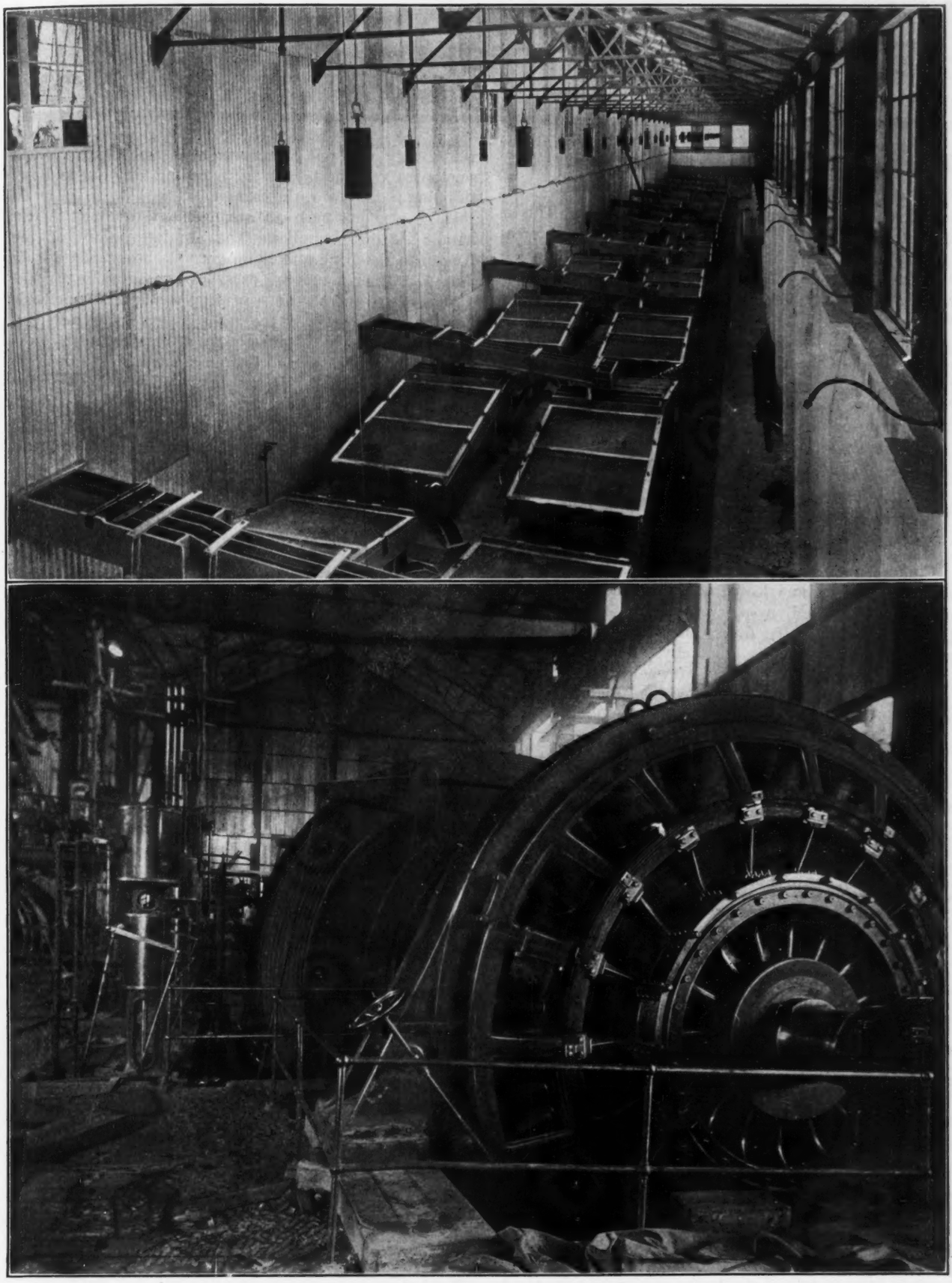
In order to prevent calcium sulphate being occluded with the metal, the electrolyte must be kept in rapid circulation. While the invention is intended primarily to use with zinc salts, the patent covers its use with other metals.

A New 50-Ton Cyanide Plant embodying counter-current decantation for the treatment of slimes has recently been completed by the Frontino & Bolivia Gold Mining Co., Ltd., which operates a group of mines in the department of Antioquia in Colombia. A small pan-amalgamation plant was also built in 1915 for the treatment of concentrates These plants are a part of a campaign of improvement inaugurated by the company several years ago. A new 10-stamp mill with 1,050-lb. stamps was started in September, 1915; the duty per stamp, according to the company report, averaged 3.3 tons per 24 hr. through 25-mesh screen. The old or upper mill has 30 stamps of 450-lb. weight and crushes about 1½ tons per stamp per day through 20-mesh screen.

Photographs from the Field



STAMP INSTALLATION AT THE CONSOLIDATED LANGLAAGTE MILL, ON THE RAND, SOUTH AFRICA
Showing the open-front mortars, long boss-heads and roller feeders of the 2,000-lb. stamp mill



MILLING INSTALLATIONS ON THE RAND, SOUTH AFRICA

The upper view shows amalgamation house of the Consolidated Langlaagte, and the lower the electric hoist at the shaft of the Crown Mines, Ltd. This hoist is one of the largest in the world and hoists an 8-ton load from 3,500 ft. of depth. The installation is recent

Correspondence and Discussion

Present Conditions in Mexico

Affairs in Mexico have undergone some improvement since the Carranza government was recognized. This is due largely to the fact that most of the Villista forces have turned to Carranza, and that foreigners have entered the country in considerable numbers, notwithstanding the fact that there has been no guarantee of life or property.

While the Villista forces have largely turned to Carranza, there are those who have not made any move in this direction. Last week the cities of Lerdo and Gomez Palacio, near Torreon, were taken and looted by forces under Argumedo and Contreras. Gen. Rosalio Hernandez apparently was dissatisfied with his treatment by the Carranzistas in Chihuahua and deserted with some of his followers. Villa is reported in the hills of Chihuahua awaiting an opportunity again to gather a following if the tide should turn against Carranza. The latest sensational development is the murder of 16 or 18 Americans in Chihuahua on the Northwestern R.R. after their train had been held up and looted and they had been robbed of their clothing and possessions by Gen. José Rodriguez. This is the fruit of the American policy in Mexico. It is not expected, of course, that any punishment can be or will be imposed for this act of wholesale murder.

It might be interesting to review the "Plan de Guadalupe" under which the Carranzistas revolted against Huerta. Its stipulations are:

1. Not to recognize Gen. Victoriana Huerta as president of the republic.
2. Not to recognize the legislative and judicial powers of the federation.
3. Not to recognize those governors of states who shall make up the actual administration 30 days after the publication of this plan.
4. For the organization of an army to fulfill these obligations, Venustiano Carranza is appointed First Chief of the Constitutionalist Army.
5. Upon the Constitutionalist Army occupying the City of Mexico, Venustiano Carranza or whomsoever shall be substituted in his stead will assume the executive power provisionally.
6. The provisional president shall convoke general elections, as soon as peace has been established, and shall deliver the power of the chief executive to whomsover has been elected.
7. In those states whose governors have recognized Huerta, the first chief of the Constitutionalist Army shall assume charge provisionally, convoking local elections, and the officers so elected shall then assume charge of their offices.

For the present Carranza has decided to make Queretaro his temporary capital. As yet nothing in the way of elections is suggested. Steps were taken in Monterey to organize political parties, but word was received that as yet such would not be permitted.

With resumption of railroad traffic, though only on a very limited scale, conditions have improved somewhat. It is possible to get food and some other necessary supplies. Permission has been given to some private parties to operate trains using their own locomotives and freight cars. The American Smelting and Refining Co. is said to have purchased 4 locomotives and 165 freight cars, which they will put into service between their various smelteries and the border for handling supplies and for shipping bullion to the border. The Cia. Minera de Peñoles also has such an arrangement, whereby it can handle its own supplies. The Monterey plant of the American Smelting and Refinining Co. resumed work on Jan. 1. Other plants are expected to resume soon.

One of the most serious handicaps under which business has to struggle is the steadily decreasing value of Carranza currency. Immediately after the present government was recognized, Carranza currency jumped to 11c. gold for a peso. It has since declined until at the present time it is selling for 5.35c. for one peso. Merchants endeavor to turn their receipts into United States drafts or currency every night. The unlimited amount that was printed by the Villistas, and which was a part of their undoing, promises to have serious consequences for the Carranzistas. Soldiers receive 2 pesos per day, or 10 to 11c. gold, which is insufficient to make any purchases of clothing, the price of which is quoted in gold or its equivalent.

It is probable that some sort of order will come out of the present chaotic conditions, but it will be at the expense of some of the impossible ideas of the present régime. When amateurs are replaced by men of age, experience and ability, then real improvement can be looked for.

S. EFES.

Tampico, Tamps., Mexico, Jan. 13, 1916.

Filling Mine Stopes with Sand

In a paper on the cyanide process, read by M. H. Kuryla at the International Engineering Congress in San Francisco last September, the question of the disposal of sand tailings was dealt with. Speaking of the Rand, Mr. Kuryla said: 'A recent trend in the method of sand-residue disposal has been to sluice the sand into dewaterers, or classifiers, from which it gravitates underground for stope filling . . . . Since its introduction on the Rand sand filling of stopes has been very advantageously adopted in other countries."

If Mr. Kuryla had used the word "before" instead of "since," he would have been more correct. I believe this process was first used in coal mines in Europe, and has been used in gold mines in Australia for the last 18 years. In the *Journal* of Sept. 23, 1911, W. H. Storms says: "The scheme may be considered scarcely to have advanced beyond the experimental stage in the metal-mining regions outside of Western Australia." This is scarcely correct, as it was in use at the Cobar Gold Mines in New South Wales in 1904 and probably before that date.

I do not know whether this system is much used in the United States now, but it seems to me that it might be used with great advantage in places like the Cripple Creek district, where dumping space is scarce and expensive.

W. MOTHERWELL.

Colorado Springs, Colo., Jan. 27, 1916.

Chrome-Iron Ore as Lining for Reverberatory Furnaces

By Edgar Hall*

SYNOPSIS—Chromite lining was tried for the reverberatory-matting furnace at an isolated mining property in Australia. Success was achieved with chromite dry-masonry lining; chromite bottom blocks bedded on a mixture of blende and chromite. Principal difficulties were with a chromite-sand layer between the matte and slag, and with the disposal of chromite "bottoms" containing absorbed metals.

In old-style reverberatory furnaces making a coarse copper matte, fettling the sides is a frequent and expensive operation. Where basic ores containing lead and zinc have to be smelted, the work is a daily nuisance and a basic lining suggests itself.

When visiting the Selby works in California in 1896, I was shown a furnace smelting basic concentrates, the sides of which were protected by chromite. Since then I have seen occasional references to the use of this mineral for furnace linings, but details of the practice do not appear to have been published or to be generally known. Hence these notes.

On my return to Australia I was anxious to try chromite linings at Silverspur, and several tons of high-grade mineral was obtained from a New South Wales deposit. It arrived in lumps of about road-metal size. Some of these were crushed finely, fines and lumps were made into a sort of concrete with fireclay, and the mixture applied by hand all around the base of the walls of a newly lined reverberatory, the idea being to protect the walls along the slag line. The lining was slowly dried and fired until glazed, before feeding a charge. It seems almost needless to say that the result was failure. The glazed surface went quickly, and the stirring of the charge washed the lumps of chromite into the middle of the furnace, whence they were raked out unaltered.

Chromite Dry-Masonry Lining a Success

We then obtained a load of chrome-iron ore, "as mined"; this was of more varied quality, in lumps of all shapes and sizes, up to as large as one man could easily handle. The small stuff was crushed and mixed with fireclay to make a mortar in which the large pieces were set as rough masonry, which was built on the smelting side of the bridge of a furnace undergoing repair. This attempt was successful, and the repaired bridge outlasted the rest of the lining. The next place tried was the "partition" leading into the flue—a very trying spot—with good results. Then a complete lining was tackled, the lower half of the walls being built of chrome and above the smelting line the usual firebrick walls; the whole of the bridge and the partition were of chromite masonry. This lasted a long while and proved an immense saving of time and fettling, practically no fettling being needed. The chromite supported the bricks until they were melted away.

It was soon noticed that the mortar would not last and that the smaller pieces of chrome worked out and were washed away into the charge, leaving holes in the walls, so it was decided to ask for a supply of the largest lumps obtainable. Horse teams were engaged to bring the largest pieces possible direct from the quarry to the furnace, and some big lumps were brought in.

A new furnace was built, the sides and bottom of which were of chrome. The largest pieces possible were built in, as close together as they could be placed, without mortar in the face joints, but set in ordinary fireclay inside and behind. Very large masses were put in front of the bridge and in the flue bottom, and the chinks filled with driven-in spalls. The bottom was carefully put in, the natural shape of the lumps being retained, and each piece fitted close to its neighbor and interlocked as far as possible. Experience with bridge and sides had shown that, as the mortar melted out, the joints became so open that it was difficult to stop a flow of slag or matte if once even a small break-through occurred. It had also been noticed that fragments of chromite mixed with blende made a heavy and infusible mixture. So it was decided to bed the lumps of chromite used for the bottom on a mixture of crushed chromite and clean blende, and to fill those spaces that could not be avoided between the lumps with the same mixture.

When finished, the inside of the furnace looked a creditable piece of work; the bottom presented an even surface, the lumps of chromite fitting together like mosaic, the sides like a well-fitting dry masonry wall. The bottom lumps averaged 10 in. in depth, the sides about 16 in. It seemed impossible that these lumps could be floated up. They never moved, and the bottom remained in perfect condition until the furnace was pulled down years later.

Basic Charge Made Highly Corrosive Slag

The hearth of this furnace was 40 ft. long by 15 ft. wide, and it was constantly at work without fettling until the roof needed repair. The slag was very basic and high in zinc and lead. The firebrick upper wall retreated considerably from the foot-wall chromite, although the latter has been exposed all the time to the wash of the molten charge. While these trials were being made, various refractory bricks were also tried; magnesia, bauxite and chrome bricks were obtained from America and Europe. All these withstood the heat, but obviously only the chrome could be used in contact with the molten charge. The magnesia bricks lasted a much shorter time than was expected, for reasons that are not clear. The bauxite bricks were an unqualified success, especially on the firebox side of the bridge, in the vulcatory arch and in the front above the skimming door, as also for the jambs and arches of the side doors.

Success now seemed attained, and the interiors of our furnaces lasted many times longer than ever before. It was evident that by the use of chrome-iron ore for bottom and sides, ultra-basic ore could be smelted to matte in reverberatories without fettling and that other repairs could be greatly reduced by the use of bauxite bricks in critical places. This method of construction was followed for a number of years, during which the composition of

*Metallurgist, Silverspur, Queensland, Australia.

the slag averaged: SiO_2, 32%; ZnO, 25; PbO, 5; FeO, 20; while the matte fall was under 3%, a charge that will be recognized as extremely corrosive.

The chromite came from Bingara, New South Wales, and the bauxite bricks from Ivryport, France; the former cost $25 per long ton and the bricks 30c. each, landed at Silverspur. At this price these furnaces are as cheap as those built of ordinary firebricks, while their lasting quality is from three to four times greater. The chromite varied in quality, but there was no apparent superiority in the use of high-grade mineral; in fact, that lower in chromium and higher in iron possesses an imperfect cleavage which makes it more convenient for masonry work. I could not see that the high heat and the corrosive action of the charge affected the chromite in the slightest degree. The mineral retains heat a long time, but its edges remain sharp. We never succeeded in finding a mortar that would last long in the side walls and after it had melted out the interior of the joints would glow white-hot long after the surface of the walls cooled to a dull red. But it wears out.

After a few weeks the molten charge, when stirred, feels as if it contained a layer of sand suspended near the top of the matte below the slag. This proves to consist of small particles of chromite, really an angular, sharp chrome sand, too heavy for the slag and too light to sink into the matte. These particles are of varying size, but are mostly quite small and are probably thrown off the large lumps by the contraction and expansion of the surface due to the changes of temperature incidental to reverberatory smelting. By this means the chromite gradually wears away.

Difficulties with Chrome Sand

This chrome sand gradually accumulates in the furnace; it cannot be skimmed out with the slag, nor tapped out with the matte. It is the one drawback to the use of chromite linings for matting furnaces. If the charge is well oxidized and the matte clean and the slag separates well, the chrome sand can, with care, be skimmed out almost free from matte globules; but the chromite has absorbed silver, and if from high-grade matte, is too rich to throw away. Even the cleaner pieces of chromite, bright black and shining and showing no minute cracks, assay over 30 oz. silver per ton. When, owing to poor roasting, zinc remains in the matte, the light zinc matte beneath the slag becomes intimately mixed with the chrome sand and forms a horrible mixture which, once set, cannot be liquefied again except after prolonged firing. This material will assay up to 200 oz. silver per ton. As this sand mixture accumulates, it delays the work of the furnace, and it should be regularly skimmed out.

Disposal of Chromite Bottoms a Problem

The recovery of the metal absorbed and retained in this mixture of chromite, slag and matte, as well as in the bottoms (which, like all bottoms, also absorb a large quantity of metal) when the latter are broken up, is important and becomes a serious matter in the case of large furnaces.

At Silverspur repeated attempts were made to clean these residues, without success. Liquation on the hearth of a new furnace was tried; crushing fine and calcining, followed by smelting with material high in lead oxide, in an attempt to flux the chrome, and other schemes were tried and all failed, the chromite resuming its old rôle every time. We decided that it is impossible to resmelt these residues in a reverberatory matting furnace. But it can be done in big lead furnaces. In a lead blast furnace, with high column and large capacity, these chrome residues, if crushed small, present no difficulty. Probably the powerful reducing conditions flux most of the chromite, and small unreduced fragments are carried out in suspension in the rapid rush of slag and are to be found occasionally showing bright in lumps of cold slag.

Possibly, when smelting straight copper ore carrying but little silver or gold, this material would be poor enough to reject. But at small mines where silver and gold form the chief value of the ore, far from railways and where lead smelters do not exist, the amount locked up in these residues may be greater than any saving to be made by the use of chromite linings. This should be taken into consideration where chromite is available and its use tempting. Otherwise, at small out-of-the-way mines, a handy supply of chrome-iron ore with which to build one's furnaces is a fine thing.

British Columbia Mining, 1915

Victoria Correspondence

Aside from the production of gold in British Columbia, the details of which have been already noted,[1] the output of other metals and minerals was important. One of the most important is silver. The output of silver, estimated at more than 3,700,000 oz., is the largest for any year since 1902. Mines in the Ainsworth-Slocan district of West Kootenay together made a production of about 2,300,000 oz. East Kootenay's proportion was about 600,000 oz.; that of the Boundary district, nearly 300,000 oz.; that of the Omineca and Skeena divisions, including silver-lead mines in the neighborhood of Hazelton and the Granby Consolidated Co.'s Hidden Creek mine on the coast, about 250,000 oz.; that from Rossland mines, between 150,000 and 160,000 oz.; that from the Britannia and other mines in the lower Coast district, nearly 70,000 oz.; with small quantities from parts of the Kootenay district not already mentioned.

In the Ainsworth division, No. 1 mine was the largest producer of silver, with an output estimated at more than 200,000 oz. Among the 25 to 30 mines in the Slocan divisions from which more or less silver came, the Standard was highest, with nearly 850,000 oz. The Hewitt-Lorna Doone came next, with about 300,000 oz.; then the Surprise, with more than 200,000 oz., and the Rambler-Cariboo, estimated at about 150,000 oz. Of Rossland mines, the most silver came from Le Roi and Centre Star group—together 131,000 oz.—while the Josie group of Le Roi No. 2 produced about 25,000 oz. Most of the silver from East Kootenay was from Sullivan ore, while in Boundary district the Granby Con.'s mines produced 195,000 oz. Of the lower Coast mines, Britannia's proportion was 55,000 oz. Granby Con.'s Hidden Creek mine, in Skeena division, produced 167,000 oz. A much larger production of silver from Omineca, Skeena and the lower Coast mines may be expected in the near future.

More than half of the 45,306,000 lb. constituting the total production of lead came from the Sullivan mine, in East Kootenay, which is now the largest lead-producing

[1] "Eng. and Min. Journ.," Jan. 29, 1916.

mine in Canada; its output was in excess of 26,000,000 lb. Of 14,000,000 lb. from Slocan mines, the Standard produced approximately 8,500,000 lb., the Surprise more than 1,600,000 lb., the Rambler-Cariboo nearly as much, and the Slocan Star perhaps 1,200,000 lb. The Hewitt-Lorna Doone and the Ruth-Hope groups each produced about 500,000 lb., while a dozen other mines in this district added their quota. Of the Ainsworth division mines, the Bluebell's output is estimated at 1,600,000 lb. and that of the Cork-Province group rather less than half that quantity, while the Utica and No. 1 each added appreciably to the total. The Emerald, near Salmo, in Nelson division, made a production of nearly 1,000,000 lb. of lead.

Record Copper Production

The year's output of copper was the highest by nearly 7,000,000 lb. of all of the 22 years which this metal has been produced in British Columbia. As compared with the 1915 total of 57,400,000 lb., the highest previous total on official record was that of 1912, of 51,456,000 lb. The chief factor in this improved situation was the Granby Consolidated Co., which produced 21,801,000 lb. from its Hidden Creek mine, Observatory Inlet, as compared with 12,128,000 lb. in 1914. Then there was 2,175,000 lb. from the Rocher Déboulé mine, near Hazelton, a property that only several months ago commenced to ship ore that was smelted at the Granby company's works at Anyox, Observatory Inlet. The production of the Britannia mine, in the Vancouver division, was about 10,000,000 lb., which was 2,000,000 lb. less than that of 1914. This decreased production was the direct result of the destruction early in 1915 of the upper terminal of the aërial tramway and other headworks at the Britannia mine by a big snow and land slide. Adding the output of the Marble Bay mine, on Texada Island, to the foregoing figures brings the Coast district (including Skeena and Omineca) total up to approximately 35,000,000 lb., as compared with between 22,000,000 and 23,000,000 lb. for the interior districts of Boundary and Kootenay, which previous to 1914 produced much more copper than did the Coast district. Approximate figures for interior districts are: Boundary and Yale 17,874,000 lb. and Kootenay 4,817,000 lb. The chief producer in the Boundary district was the Granby Con., which shipped from its mines in Phœnix camp ore that yielded 16,046,000 lb. of copper, while the British Columbia Copper Co. produced 1,505,000 lb., and the Iron Mask mine at Kamloops shipped ore to Trail from which it is estimated 350,000 lb. was recovered. Of Rossland mines, Le Roi is thought to have produced 2,800,000 lb., the Centre Star group, 1,086,000 lb., and the Josie group, 895,000 lb.

The estimated total of 12,000,000 lb. of zinc as the production of 1915 by no means shows all the zinc, for much was concentrated but not sold, so it remained in storage at the mines. As a case in point, the Slocan Star had on the dump approximately 1,500 tons of concentrates averaging about 35% zinc, which was a second product made when concentrating lead-zinc ore last year. That lot alone represented about 10,000,000 lb. of zinc not included in the estimate of the production of 1915, and there were also zinc concentrates stored at other mills.

Excepting 1,300,000 lb. estimated as having been produced from zinc carbonate ore shipped from the Hudson Bay mine in the Nelson division, about 500,000 lb. from the Monarch mine, near Field, Northeast Kootenay, and 600,000 to 700,000 lb. from Retallack & Co.'s Whitewater mine, in the Ainsworth division, the zinc production of the year was made at Slocan mines and mills. The Standard shipped concentrates containing 3,789,000 lb., the Surprise about 2,358,000 lb. and the Hewitt-Lorna Doone, Lucky Jim, Rambler-Cariboo, Slocan Star, Galena Farm, and others, a quantity the detailed production of which is not known. There seems no room for doubt, though, that the estimate of a total production of 12,000,000 lb. in 1915 is well within the mark.

There was no commercial production of iron ore in the province, nor was there much further development of the known deposits during the year. A known occurrence of molybdenite ore had a little attention, and following the shipment of 24 tons to Denver, Colo., in 1914, a second similar shipment was made last spring, also to Denver. Afterward the property was bonded by Vancouver, B. C., men, but they have not since made any production, so far as known. Some antimony ore was mined on claims situated at a high elevation in Slocan mountains; one carload was shipped to England and another to Chicago, but no information was made public concerning results. A number of placer miners sought to recover platinum from the Tulameen river and tributary creeks, in which it occurs in association with gold, but the total production in 1915 was not of considerable value, probably only $2,000 or $3,000.

The gross production of coal—that is, before deduction of that made into coke—was 1,961,000 long tons as compared with 2,166,000 in 1914. About 409,000 tons was used in the coke ovens, leaving a net output of coal, sold as such, of 1,552,000 tons. Vancouver Island collieries produced 1,010,000 tons, Nicola mines 88,000 tons, the Princeton colliery in Similkameen district 13,000 tons, and the collieries of the Crowsnest district in Southeast Kootenay 850,000 tons.

The largest producer on Vancouver Island was the Canadian Collieries (Dunsmuir), Ltd., with a total output of 425,000 tons; the Western Fuel Co.'s production was 411,000 tons; that of the Pacific Coast Coal Mines, Ltd., 127,000 tons. In Crowsnest district the Crow's Nest Pass Coal Co. made an output of 797,000 tons, and the Corbin Coal and Coke Co. of 53,000 tons.

Of the coke production of 248,500 long tons, 239,200 was from the Crow's Nest Pass Coal Co.'s ovens at Fernie and Michel, and 9,300 tons at those of the Canadian Collieries, Ltd., at Union Bay, Vancouver Island.

Among the miscellaneous mineral products of British Columbia are portland cement, building stone and other rock, clay products, sand and gravel, etc. As there was much less construction work done in 1915 than in any one of several previous years, it follows that structural materials were used to a smaller extent.

Record of Metallurgical Progress

Gratifying progress was made in 1915 at the smelting works and refinery of the Consolidated Mining and Smelting Co. at Trail, and at the smeltery of the Granby Consolidated Mining, Smelting and Power Co. at Anyox, Observatory Inlet.

At Trail, the Consolidated company completed its arrangements for bedding copper ores previous to smelt-

ing, and put in two 12-ft. Great Falls type copper converters. The turbo-blower for the converters is of 15,000-cu.ft. capacity and is driven by a 900-hp. motor. In the lead department a third large furnace was built—water-jacketed throughout. A new lead-sampling mill, capacity 100 tons per hr., was constructed; it is so built as to allow of its being operated in sections, which will admit of any section being repaired without necessitating stoppage of the whole of the mill. The Cottrell dust-collecting plant connected with the lead furnaces has been doubled in size, and another similar plant added for treating the fumes from the roaster. A third Cottrell plant is being provided for fumes from the copper converters and part of the roaster gases. Another Wedge furnace is approaching completion in the roasting department, and extra blowing capacity is being provided for the Huntington-Heberlein converters. Another 20-ton crane has been put in this department. The electrolytic lead refinery has been enlarged, concrete tanks have been substituted for wooden ones, and the whole refinery has been floored with concrete, the better to save spilled metals or electrolyte. Experimental work in connection with the production of electrolytic zinc having been successful, a commercial plant is being provided, to have a capacity of possibly 35 tons of spelter per day. Buildings of steel and tile construction covering about six acres of ground include those for grinding, roasting, leaching and electrolyzing plants, melting building, motor-generator building, transformer station, etc.

Granby Consolidated's Changes

At Anyox, the Granby Consolidated Co. constructed a fourth furnace and added an agglomerating plant to deal with flue dust, converter slag and matte, and also made many less important but effective changes and improvements. The company's superintendent of smelteries says: "We have found the Anyox plant fairly well designed for economical work and have made very few changes. So far we have found it to be the better practice to regrade our copper matte, giving to the converter nothing less than 20 to 25 per cent. Cu matte. . . . The making of converter grade of matte in the first smelting will, we believe, eventually be accomplished."

The Britannia Mining and Smelting Co. has made progress with the construction of the first and second 1,000-ton units of its new concentration mill. The chief features of ore treatment here are fine grinding and the Minerals Separation flotation process, which this company adopted several years ago. Blake crushers, heavy and fine rolls, Hancock jigs, granulators, etc., are included in the machinery and plant installed here.

No commercial recovery of zinc has yet been undertaken by the company which has done much experimental work with what is known as the French process, initiated by the late A. Gordon French. Treatment of silver-lead-zinc ore by flotation is being continued at the mill of the Silverton Mines, Ltd., Slocan. In the same neighborhood the Standard company is experimenting with a flotation process. J. P. Keane last October commenced operating the Rosebery concentrating mill as a custom plant and has since been concentrating zinc-lead ore from the Lucky Jim mine in eastern Slocan. A new mill has been constructed and is in operation on zinc-lead ores at the Galena Farm mine, near Silverton, Slocan Lake.

Additions to the Hedley Gold Mining Co.'s 40-stamp mill, Similkameen, include a 24-36-in. Traylor jaw crusher, another 5x22-ft. tube mill, Dorr classifier, four large cyanide tanks, and a third Oliver continuous filter.

Dividends paid in 1915 by metal mining companies operating in British Columbia were:

MINING COMPANY DIVIDENDS

Consolidated Mining and Smelting Co.	$464,398.00
Granby Consolidated M., S. and P. Co.	449,955.45
Hedley Gold Mining Co.	300,000.00
Le Roi No. 2, Ltd. (two dividends of 1s. each)	58,320.00
Standard Silver-Lead Mining Co.	250,000.00
Total	$1,522,673.45

The Consolidatel Mining and Smelting Co. of Canada, Ltd., in December declared a dividend, payable in January, at the rate of 10% per annum, instead of 8% as previously. The Motherlode Sheep Creek Mining Co., with gold mine and mill in Nelson mining division, on Dec. 10 declared a dividend of 11% payable Jan. 3; it is stated the total of this distribution was $135,000.

Naval Consulting Board

We have previously chronicled the appointment of a naval consulting board, authorized by the Secretary of the Navy, out of the membership of the great national engineering societies. The scope of this board is being further enlarged, at the request of the President of the United States, on the lines suggested in the following communication:

The White House
Washington

January 13, 1916.

My Dear Sir—The work which the American Institute of Mining Engineers has done through its members on the Naval Consulting Board is a patriotic service which is deeply appreciated. It has been so valuable that I am tempted to ask that you will request the Institute to enlarge its usefulness to the Government still further by nominating for the approval of the Secretary of the Navy a representative from its membership for each state in the Union to act in conjunction with representatives from the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Chemical Society, for the purpose of assisting the Naval Consulting Board in the work of collecting data for use in organizing the manufacturing resources of the country for the public service in case of emergency. I am sure that I may count upon your cordial coöperation. With sincere regard,

Cordially yours,

WOODROW WILSON.

Mr. W. L. Saunders, President, American Institute of Mining Engineers, New York City.

The Board of Directors of the American Institute of Mining Engineers has already taken active steps in this matter, the purpose of which was ably explained by President Saunders at the last meeting of the New York section.

Safety-First Exhibit To Be Held at Washington

There will be held in Washington during the week of Feb. 21-26 inclusive a safety-first exhibit in which all the Government departments are taking an active part. Secretary of the Interior Lane has sent a letter to the governor of each state inviting him to send a delegate and asking that the chief mine inspector, a representative of the industrial commission, or of other agencies engaged in compiling statistics relating to the various mineral industries, attend this exhibition. It is hoped that all interested persons will visit the safety-first exhibit and attend the conference of state mine inspectors, which will be held on Feb. 24, at the office of the United States Bureau of Mines.

Editorials

Production and Stocks of Copper

On the basis of returns made to us by all of the copper refiners and selling agencies in the United States, we are able to report the production of refined copper in the United States in 1915 as having been 1,652,775,822 lb. The stock on hand Dec. 31, 1914, was 162,566,683 lb.; the stock on hand Dec. 31, 1915, was 84,666,380 lb.

The reports of stocks include all of the refined copper, consisting of electrolytic (ingots, cakes, wire bars and cathodes) and casting and lake copper at works and in warehouse elsewhere than at works at the end of the last day of December of each year. In reporting the stocks of refined copper at works or in warehouse, all of the refined copper existing there, whether sold or unsold, or held for the account of the refiner reporting or that of somebody else, was included.

Several of the producers reported that all of the copper in their refineries Jan. 1, 1916, was disposed of and simply awaited shipping opportunities. At that time, as is well known, the freight embargo on certain railways and difficulties in making shipments generally had delayed the forwarding of copper that had already been purchased by manufacturers and was eagerly wanted by them.

PRODUCTION AND STOCKS OF COPPER

Year	Supplies	Production	Stock, Dec. 31
1913.....	*1,649,430,326	†1,622,450,829	†91,438,867
1914.....	*1,492,843,502	‡1,533,781,394	*162,566,683
1915.....	§1,776,250,869	*1,652,775,822	*84,666,380

*As reported by "Engineering and Mining Journal." †As reported by the Copper Producers' Association. ‡As reported by the United States Geological Survey. §Preliminary figure reported by "Engineering and Mining Journal," subject to revision.

The statistics of copper production and stocks are summarized in the accompanying table. In the column headed "Supplies" is entered the production of the mines and smelting works of North America that goes to American refiners plus the crude copper imported for refining—in other words, the supply of crude material going to the refiners. These are the figures reported in our issue of Jan. 8, 1916, which are based on the reports from the smelters, that is to say they may be assumed as the mine production.

As we have pointed out in previous statistical discussions, it should not be attempted to draw too fine deductions from a comparison of the statistics of crude-copper production and refined-copper production. However, the figures in the accompanying table show, in a general way, how in 1914 the production of crude copper was curtailed before the production of refined copper could be, and how in 1915 the opposite occurred, the production of crude copper expanding in advance of the production of refined copper. The latter occurred manifestly in the first half of the year especially. By the end of 1915 it is highly probable that the productions of crude and refined copper were going pretty well in step.

The surplus of supplies in 1915 was of course taken up to a large extent in filling the normal channels of the trade—the railway cars on the way from smeltery to refinery, the electrolytic vats, etc.—which had previously been drained to the basis corresponding with the curtailed production of the winter of 1914-15. The time from the shipment of blister copper from the smeltery to the delivery of refined copper from the refinery is two to three months. Thus, in 1915 the mines and smelteries were getting into full swing early in the second quarter of the year, but it was not until the third quarter that the capacity of the refineries began to be taxed severely.

Another Call to the Engineer Toward Preparedness

The public recognition due the engineer, so long withheld, owing partly to the unassuming members of the profession themselves, is now becoming a matter of nation-wide importance, thanks to the War. The great national engineering societies are looming large in the strides toward preparedness, now the insistent demand of the country. The American Institute of Mining Engineers has a member on a joint committee which is working with the War College on plans to direct, train, mobilize and utilize the engineering talent of the country. Four members of the Institute are members of the Naval Consulting Board. W. L. Saunders, president of the Institute, has lately received a letter from President Wilson, published on page 270 of this issue.

The plans contemplate the gathering of information that will enable the Government to know where it can obtain all the supplies it will need to provide, as sinews of war, to its military and naval forces—besides munitions, clothing and food, the host of other things required, reported to total 50,000 separate items in the British army list, including such detail as bitter aloes to put on halter ropes to prevent gnawing by horses. An inventory of the country's producing and manufacturing resources and transportation facilities will in effect be accomplished.

These five engineering societies have a membership of about 36,000 technical men scattered throughout the country. As members of these societies, their standing is assured and will not only inspire confidence in their efforts in this work, but will remove them from any suspicion of partisan or pecuniary interest in the subject.

History shows us that since medieval times when geometry was introduced into military science, the engineer has been of steadily increasing importance in every branch of warfare. With the enormous numbers of men which modern warfare involves, their supply, subsistence and transport, together with the tremendous strides in the mechanism of all destructive machinery, the engineer has become preëminent in military service, and the common soldier is no longer a bruiser but a skilled mechanic. In active service the engineer precedes the army to make its passage possible, and its position is made tenable only by the engineer and his system of communication in the rear. For an army of 100,000 men in Galicia, Col. John Biddle, of the United States Army, recently stated that

the line of communication in the rear for supplying this number of men extended 100 mi. and required the services of 30,000 men (presumably prisoners of war) over whom were 20,000 guards.

The work of the engineer in the field, however, must be preceded by the work of the engineer at home in time of peace, and the move to mobilize the engineering talent and manufacturing capabilities of this country is the biggest stride yet taken toward proper preparedness and puts the engineer in the forefront of the movement which is the most patriotic and the most necessary to our national existence.

The mining engineers are proud of this call from their country and are glad that an opportunity is offered to larger numbers of the profession to perform service which we are all sure will redound to the credit of the individual, the Institute and the profession, and make the title of engineer as creditable a one as engineering achievements have long since merited.

Revision of the Mining Law

The bill for the creation of a commission to recommend a revised code of mining laws for the United States, which was passed by the Senate, was substituted in the House Committee on Mines and Mining for the bill that had been introduced by Mr. Taylor, of Colorado. After a series of hearings and considerable discussion, the bill was defeated last week by a majority of one vote.

The demand for this reform is so emphatic, however, and the impetus that has been given to the movement is so strong that the recent disposition of the matter by the House committee will not be regarded as final. In a subsequent article we shall inform our readers fully respecting the situation of this legislation and what is operating against it.

Building a Science

The immense importance of the flotation process and its wide field in the metallurgical operations of the present day have led to a concentration of efforts to clarify its basic principles. Much of this effort, naturally, has been misdirected, and a great deal more of it has been applied at the wrong point. The right way to understand fully any principle is to begin at the bottom, to follow its growth from the roots. Flotation, up to the present time, has no roots, or perhaps it would be better to say that the roots have not yet been discovered, although they unquestionably exist. Much effort has been spent on the practical applications of the process, examining the behavior of ores of various character under the varying conditions of known flotation essentials. This procedure is like beginning in the middle of a story and following through to the conclusion without knowing what it is all about. The study of flotation ought to begin with basic facts. We ought to know the chemical and physical properties of finely divided solids, with which flotation is particularly concerned.

In order to assist in the elucidation of these fundamental principles, the *Journal* begins in this issue a series of articles by E. E. Free, dealing with colloids and their relation to ore dressing. Colloids, of course, form only a part of the problem of flotation, but it is an interesting and important part. Extremely fine solids may depart from the characteristic behavior of ordinary particles and acquire new tendencies under the influence of surface forces. It is to the explanation of these new forces that these articles are devoted, and the information gained from them may be of vital importance in the elaboration of a tenable theory.

We commend to all readers interested in flotation—and what engineer is not at the present time—a careful perusal of Mr. Free's articles and those prepared by the experts who have added their assistance. It is expected that important facts will be brought out—facts that may aid by directing attention to channels hitherto unconsidered.

Index to Volume 100

The *Journal* index, covering the latter half of 1915, will be mailed with the issue of Feb. 5. Any subscriber who does not receive his copy should notify the *Journal* promptly.

The intention is to make this index comprehensive, embodying a liberal selection of news notes together with more important articles, but at the same time concise. Under these conditions some explanation of the method is useful as an aid in finding the leading articles quickly. Simple series of page numbers, following the names of mines or companies, generally refer to lesser matters. Descriptive articles on the same are appended under titles beginning with dashes. Where the references are numerous, as in the case of "Anaconda," the minor ones are sometimes separately designated as "Notes." The unspecified entries may, however, be important; occasionally, for instance, an editorial or other article is entitled simply by a proper name. Thus, the entries relating to the Clifton-Morenci strike begin with a number of major ones not distinguished in detail, followed by some which are so distinguished and by a group of notes at the end. With a major entry, or series of entries, may be placed several minor ones relating to the same subject in order that its history may be followed. Great pains have been taken in bringing related matter together in a systematic form. The asterisks denoting illustrated articles assist in finding them, and if the author's name be known, it is the simplest means of reference. Productions are indexed under names of metals and countries or states, in important cases under both. The mere juxtaposition of a mineral and geographical name usually signifies an output, but may cover other statistical or news matter.

The Director of the United States Geological Survey draws our attention to an error that we made inadvertently in our issue of Jan. 22, in saying that "there was no statement of the production (of copper) by American refiners and none of the stock on hand at refineries either at the beginning or end of 1915." The Geological Survey had published statistics of the stock on hand at the beginning of 1915 and the production during the year. In making the remarks that we did, we had in mind, of course, the absence of statistics of the Copper Producers Association, which was dissolved in 1914.

The policy of publicity in technology has made enormous strides. Nowadays there are but few mining and metallurgical companies that do not tell freely about their

practice and permit their employees to contribute articles on technical subjects to the periodicals and the transactions of the societies. Some of the concerns that have not advanced so far as that have nevertheless opened their doors sufficiently to admit technical visitors. There are, however, some that do neither one thing nor the other, usually owing to the resistance of some shellback at the head of the company. This is apt to be extremely mortifying to the members of the technical staff of such a company. They naturally want to travel, visit the works of other companies and keep up with the times generally. Their own superiors want them to do this, but in doing so they are obliged to accept courtesies that they are unable to reciprocate.

BY THE WAY

A new arrangement has been made for collecting statistics of the British iron and steel trades. This work has been carried on by the British Iron Trade Association, and it is admitted that it has not been satisfactorily done. Now the collection and tabulation is to be undertaken by the Iron and Steel and Allied Trades Federation, which has established a statistical bureau in London to be under the supervision of G. C. Lloyd, secretary of the Iron and Steel Institute. It is stated that Mr. Lloyd has the confidence of the manufacturers generally.

⁂

In the *Journal* of Dec. 18 is a market tip, page 1021, in which some of the expected prices for copper shares seemed a little high. The writer of the original seems to have lost some of his optimism and now says:

Metal prices warrant an immediate advance in all of the copper stocks. There is hardly a copper in the list that is not entitled to sell at higher prices. Many of the lower-priced issues should double in value, and will no doubt do so when the expected big market is well under way. Among those predicted to sell higher is Calumet & Hecla to above $600. Anaconda should sell at $100, also Utah Copper, Mohawk, Osceola, Quincy and Calumet & Arizona. Ahmeek should sell at $125, Miami at $50, Chino at $75, East Butte at $25, North Butte at $40, Granby at $100. Among the lower-priced coppers, Franklin should double, also South Lake, Santa Fe and Davis-Daly. In our opinion Hancock is a buy, also Isle Royale, Magma, Kennecott, Ray Consolidated, Copper Range, Keweenaw, Greene, New Arcadian, Superior and New Baltic.

The original gave Calumet & Hecla as good for $1,000; Utah, $150; Miami, $75; Chino, $100; etc. Why does the office boy write the copper-market letters?

⁂

Among those things which are interesting if true is the following from the *Daily Mining and Financial Record*, of Denver. C. E. Patterson, of Graham County, Arizona, filed a relocation in Pima County on Dec. 10 on a "lost mine." There is some Mexican history connected with this mine which is near the Mexican border west of Nogales. About 60 years ago Gen. Ignacio Pesquiera, later governor of Sonora, when in political and financial straits crossed the line with about 500 soldiers and engaged in mining. Just where he operated was not known, but he took out enough gold to rehabilitate himself and finance a war which resulted in his conquest of Sonora. Since then men have hunted for the Pesquiera mine, believed to be somewhere in the Arivaca region. There were numerous placers in the country where the mine was supposed to be, and they have been worked in a small way for half a century. Larger scale operations would have been carried on but for the lack of water. Mr. Patterson went into that country and he observed one thing that had escaped the attention of earlier hunters for the Pesquiera mine. He noticed a growth of water weeds and trees, the latter of considerable girth, along a comparatively straight line, indicating that there had been at some time a disturbance of the surface so that water found a way to the roots of this vegetation. He made an investigation along this line and found a trench he believed had been made by Pesquiera's miners. He employed men to clean it out, and that has been done for a distance of about 500 ft. to a depth of 30 ft. He is now on a vein of sulphides for that length. The vein is 5 ft. wide.

⁂

January Mining Dividends

Mining dividends paid in January, 1916, by 30 United States mines amounted to $6,758,276, as compared with $2,516,551 paid by 17 mines in January, 1915. Industrials allied to mining paid $4,231,879 in 1916, as against $4,085,688 in 1915, while Canadian, Mexican and Central American companies paid $1,732,257 in January this year, against $1,114,508 in 1915 and $2,505,321 in 1914. The above figures are exclusive of a return of capital by Stratton's Independence, Ltd., of $121,500 (6d. per share).

United States Mining Companies	Situation	Per Share	Total
Ahmeek, c	Mich.	$2.50	$125,000
Allouez, c	Mich.	1.00	100,000
Bunker Hill Con., g	Calif.	.02½	5,000
Bunker Hill & Sullivan, l.s	Ida.	.25	81,750
Butte-Alex Scott, c	Mont.	.15	11,897
Caledonia, l.s	Ida.	.02	52,100
Camp Bird, pfd., g	Colo.	.....	110,565
Champion, c	Mich.	3.00	300,000
Golden Center, g	Calif.	.04	5,750
Golden Cycle, g	Colo.	.02	30,000
Hecla, l.s	Ida.	.10	100,000
Homestake, g	S. D.	.65	163,254
Iron Blossom, s.l.g	Utah	.05	50,000
Lake View, z	Utah	.02½	11,250
New Jersey Zinc, z	U. S.	10.00	3,500,000
North Butte, c	Mont.	.50	215,000
National Lead and Zinc, l.z	Mo.	.04	20,000
Osceola, c	Mich.	3.00	288,450
Portland, g	Colo.	.03	90,000
Shattuck-Arizona, c	Ariz.	1.00	350,000
Silver King Coalition, s	Utah	.15	187,500
South Eureka, g	Calif.	.07	20,999
St. Mary's Mineral Land	Mich.	1.00	160,000
Stratton's Independence, g	Colo.	.12*	121,500*
Stratton's Independence, g	Colo.	.04	40,500
Success, s.l	Ida.	.03	45,000
Tennessee, c	Tenn.	.75	150,000
Tonopah Belmont, g.s	Nev.	.12½	187,504
Tonopah Extension, g.s	Nev.	.07½	70,757
Tonopah Mining, g.s	Nev.	.15	150,000
Utah-Apex, c	Utah	.12½	66,000
Vindicator, g	Colo.	.03	45,000
Wasp No. 2, g	S.D.	.05	25,000

* Return of capital.

Industrial and Holding Companies	Situation	Per Share	Total
Am. Sm. Sec., pfd. A	U. S., Mex.	$1.50	$252,450
Am. Sm. Sec., pfd. B	U. S., Mex.	1.25	375,000
Bethlehem Steel, pfd	U. S.	1.75	239,625
Greene-Cananea	Mex.	1.00	486,209
Guggenheim Expl	U. S., Mex.	1.00	833,732
Lanyon-Starr, z	Mo.	3.00	75,000
Pennsylvania Salt	Penn.	2.00	100,000
Pittsburgh Steel, pfd	Penn.	3.50*	225,000*
Republic I. & S., pfd	U. S.	2.75†	561,465†
St. Mary's Mineral Land	Mich.	1.00	160,000
Sloss Sheffield, pfd	Tenn.	3.50‡	234,500‡
U. S. Smelting, pfd	U. S., Mex.	.87½	425,562
U. S. Smelting, com	U. S., Mex.	.75	263,336

* On account of back dividends. † Includes $1.00 on account of back dividends. ‡ Includes $1.75 on account of back dividends.

Canadian, Mexican and Central American Companies	Situation	Per Share	Total
Alaska Goldfields, g	Yukon	$0.12	$30,375
Butter's Salvador, g.s	C. A.	.36	54,675
Consol. M. & S. of Canada	B. C.	2.50	149,123
Greene Consol., c	Mex.	.50	500,000
Hollinger, g	Ont.	.04	120,000
La Rose, s	Ont.	.05	37,466
McKinley-Darragh, s	Ont.	.03	67,431
Motherlode Sheep Creek, g	B.C.	.11	135,000
N. Y. & Honduras Rosario, g	C. A.	.05	100,000
Nipissing, s	Ont.	.25	300,000
Peterson Lake, s	Ont.	.01¼	63,000
Porcupine Crown, s	Ont.	.03	60,000
Standard, s.l	B. C.	.02½	50,000
Tough-Oakes, g	Ont.	.12½	65,187

United States Steel Corporation

The preliminary report of the United States Steel Corporation for the quarter ended Dec. 31, 1915, enables us to complete an outline of its operations for the year. These conformed nearly to the general course of the steel trade and showed a remarkable recovery from the depression which marked the close of 1914. The first quarter reached almost the lowest level ever reported, the second showed a large increase, while the fourth reached the highest point on record. Undoubtedly the demand for steel for exports began the revival, but that demand was soon followed by a great increase in domestic business, and the two together resulted in a boom that has placed the trade generally and the U. S. Steel Corporation itself in a position of prosperity that was hardly anticipated a year ago. The result will be a large expenditure for extensions and improvements, which were to some extent neglected during two years of depression, though not altogether omitted, as the near completion of the Duluth plant shows.

Results of the Fourth Quarter

The results for the fourth quarter of the year are given in condensed form as follows, net earnings being the earnings after deducting working expenses, ordinary repairs and renewals and interest on subsidiary bonds:

Net earnings:	1913	1914	1915
October	$11,430,461	$5,580,533	$16,563,854
November	7,392,166	2,798,388	16,990,968
December	4,213,722	2,554,249	17,677,966
Fourth quarter	$23,036,349	$10,933,170	$51,232,788
Balance, adjustment of accounts, etc.			794,057
Total net			$52,026,845
Depreciation, replacements, subsid. cos.		$10,379,675	
Interest, etc., Steel Corp. bonds		5,687,777	
Total fixed charges			16,067,452
Balance, surplus for quarter			$35,959,393

From this surplus the directors declared the usual dividend of 1¾% on the preferred stock, $6,304,920; also a dividend of 1¼% on the common stock, $6,353,731; the total of dividends being $12,658,701, leaving a balance of $23,300,692 as undivided surplus for the quarter. The common stock dividend is the first declared since the third quarter of 1914, when ½% was paid.

The month of December showed the largest net earnings ever reported for one month. The fourth quarter also established a record, the earnings exceeding those of any preceding quarter in the history of the corporation.

Earnings for the Full Year

The condensed statement for the year as made up from the quarterly statements published is as follows:

Net earnings:	1913	1914	1915
First quarter	$34,426,801	$17,994,381	$12,457,809
Second quarter	41,219,813	20,457,596	27,950,055
Third quarter	38,450,400	22,276,002	38,710,644
Fourth quarter	23,036,349	10,933,170	51,232,788
Year	$137,133,363	$71,661,149	$130,351,296
Add adjustment of accounts, etc.			794,057
Total net for 1915			$131,145,353
Depreciation, replacements, subsid. cos.		$26,018,889	
Interest and sinking fund		28,543,232	
Total fixed charges			54,562,121
Total surplus			$76,583,232
Dividends declared			31,573,458
Undivided surplus			$45,009,774

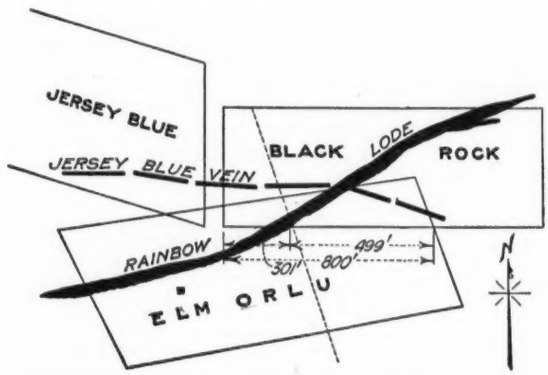
The dividends declared for 1915 were 7% on the preferred stock and 1¼% on the common stock. Only one dividend, that for the fourth quarter, was declared on the common stock. The company's total surplus at the close of the year was $215,277,998, of which about $105,000,000 was cash in bank. The unfilled orders on the books on Dec. 31, 1915, amounted to 7,806,220 tons of material of all kinds.

The details of the year's business, including the proportions of domestic and export business, will not be available until the complete annual report for the year 1915 is issued.

Elm Orlu-Butte & Superior Apex Decision

Butte Correspondence

The decision in the case of the Clark Montana Realty Co. against the Butte & Superior Copper Mining Co. handed down by Judge George M. Bourquin of the United States District Court in Butte, Saturday, Jan. 22, was claimed by both sides as a victory. The facts seem to be that it was a compromise in which the Butte & Superior got slightly the better of it, as far as the immediate situation is concerned at least. Mining rights, the value of which is estimated at $20,000,000, were involved.



ELM ORLU AND BUTTE & SUPERIOR CLAIMS

On the point of priority, the court held that the Elm Orlu was located before the Blackrock claim. The most vital point in dispute, as far as immediate effects are concerned, dealt with the disputed part of the Rainbow lode, where mining operations have been carried on and where great bodies of valuable ore are blocked out.

The Clark interests were awarded the right to all the ore of the Rainbow lode west of a plane parallel to the end lines of the Elm Orlu and drawn through a point 301 ft. from the southwest corner of the Blackrock lode on the common side line.

The Butte & Superior was awarded all the ore in the Rainbow lode east of that point. The common line extends a distance of nearly 850 ft., and this gives the Butte & Superior about 550 ft. of the disputed part of the Rainbow lode. In this the Butte & Superior has done considerable mining and taken out quite a large amount of ore, and the decision gives it practical title to all the ore taken from there.

If on further development it is found that the Rainbow lode goes into the Jersey Blue claim and has any orebodies of value, they will belong to the Elm Orlu. However, that is a question of future development. The entire title to the Jersey Blue vein is given to the Butte & Superior. The decision holds that the Jersey Blue vein

apexes in the Blackrock claim and does not unite with the Rainbow vein.

The Creden vein, the decision holds, diverges from the north side of the Rainbow vein in the Elm Orlu claim and has its apex in both the Elm Orlu and Blackrock claims.

The court holds that each party has mined orebodies belonging to the other and that an accounting must be made for this. The conclusions were as follows:

That the Clark interests own all the orebodies in the Rainbow vein between the Elm Orlu west end line and a parallel line projected from where the south-wall apex of said vein crosses the common side line, or about 980 ft. of said vein. (This includes the 301 ft. that was in the disputed territory.)

That the Butte & Superior Mining Co. owns all the orebodies in the Rainbow vein between the projected Elm Orlu end line at the south-wall apex crossing of the common side line by said vein and the east-end line of the Blackrock claim, or about 1,200 ft. of said vein. (This includes the 550 ft. of disputed territory.)

That the Clark interests own all orebodies in the Pyle strand from its divergence at its west end from the Rainbow vein in the Elm Orlu claim easterly as far as the apex of said strand is within said claim, and between Elm Orlu end lines projected.

The Butte & Superior owns all east of the projected east-end line aforesaid.

The Butte & Superior owns all the orebodies in the Jersey Blue vein between the points where the apex departs from its premises across the end lines as laid or projected, throughout depth save at its intersection or crossing of the Rainbow vein between the Elm Orlu end lines as laid and projected.

The Clark interests own all the orebodies in the Creden vein from its divergence at its east end from the Rainbow vein westerly as far as the Creden apex is within the Elm Orlu claims between the Elm Orlu end lines there projected.

The Butte & Superior owns all west of the projected west-end line last aforesaid.

An accounting in damages to be had.

Each party pays its own costs.

Under the decision the Butte & Superior has all the mining rights it has been exercising even in disputed territory and will be able to continue operating in that territory as well as securing additional territorial rights that were tied up in the dispute. It did not get all it expected. Neither did the Elm Orlu. The court in conclusion called attention to the fact that the decision would probably be a disappointment to both sides.

In rendering the decision, Judge Bourquin stated that the testimony in the suit failed to establish a preponderance of evidence that would entitle either party to all the claims made by each. He also established a record in court proceedings by refusing to be influenced by technicalities or flaws in the present or previous proceedings that would, if taken into account, work an injustice to either party.

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Pre-Cambrian Gold Fields of Central Canada*

The following conclusions would seem to be justified from the consideration of the Pre-Cambrian rocks of the Canadian Shield. Whether these conclusions will apply to, or have any significance in, Nova Scotia, southeastern Quebec and the Appalachian region generally, the author has not yet determined.

1. The veins are Pre-Huronian in age, no gold-bearing veins having been recorded in rocks of Huronian age in central Canada.

2. They frequently occur in both basic and acidic rocks of Keewatin age.

3. Wherever the later Temiskamian rocks are present in association with the Keewatin rocks the gold-bearing veins are clearly determinable as being younger than the Temiskamian series.

4. They are very generally associated with albite-porphyries.

5. These porphyries, etc., may reasonably be regarded as apophyses from batholithic granite intrusions of Laurentian and Algoman age.

6. The gold-quartz veins have not been found, and do not seem to occur, in the body of the batholiths of granite or gneiss, whether these are of Laurentian or Algoman age, as evidenced by their absence in the vast areas of hundreds of thousands of square miles in northern Canada, where such granites alone are well exposed.

7. In the Algoman period, in which most, if not all, of the gold-bearing veins in the Pre-Cambrian rocks of central Canada would appear to have been formed, we have a chrysogenetic epoch, during which gold rose from the deeper parts of the earth and was deposited in such fissures as occurred in the rocks at the time, no matter through what agencies those fissures were produced.

8. The existence of a single epoch in the Pre-Cambrian, characterized by the formation and presence of veins carrying such a distinctive and much sought for mineral as gold, should be of great service in assisting in the determination of the age of other formations in these old rocks, where so many criteria which can be used in the determination of the age of later rocks are not available.

*Excerpt from paper by J. B. Tyrrell, F. R. S. C., 534 Confederation Life Building, Toronto, Canada, in the "Transactions" of the Royal Society of Canada.

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Copper Exports and Imports

Exports of copper from the United States for November, 1915, and the 11 months ended Nov. 30 are reported as follows by the Department of Commerce, in pounds:

	November	11 Months
Ore, concentrates and matte, contents.	427,992	2,329,833
Unrefined, blister, etc.	60,042	262,281
Ingots, bars, etc.	56,601,142	509,508,095
Plates and sheets	7,584,456	30,869,692
Wire	2,616,512	46,684,287
Old, scrap, etc.	15,377	6,679,427
Total	67,305,521	596,333,615

In addition, manufactures of copper—weight not given—were exported, valued at $1,106,475 in November, and $6,884,391 for the 11 months.

The imports of copper for November, 1915, and the 11 months ended Nov. 30 are given as below, in pounds:

	November	11 Months
Ore, concentrates and matte, contents.	6,838,077	104,408,233
Unrefined, blister copper, etc.	11,942,452	86,798,669
Bars, plates, etc.	2,709,503	81,181,397
Old and miscellaneous	974,434	6,933,789
Total	22,464,466	279,322,088

The actual tonnage of ore concentrates and matte, of which the copper contents are given, was 35,516 tons in November and 386,694 tons for the 11 months.

Elsewhere in this issue a tabulation is given of copper stocks on hand in the United States.

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The Estimate of Portland-Cement Output in 1915, made by the United States Geological Survey, indicates shipments from the mills of 86,524,500 bbl., an increase of 0.1% over 1914. There was a slight decrease in production, and this, with the appreciable decrease in stock, indicates a more conservative trend in the industry, which in the preceding few years showed a tendency to overproduction. Prices generally averaged a few cents lower per barrel in 1915 than in 1914, although toward the end of the year prices were substantially increased, and the outlook for 1916 is brighter than for several seasons.

PERSONALS

L. F. S. Holland is examining properties at Patagonia, Arizona.

Frank H. Probert left San Francisco, Jan. 22, for Mohave County, Arizona, on professional work.

Henry Mace Payne has returned to London from Petrograd and will sail for America early in February.

Chester A. Fulton is in Cuba, examining mines in the province of Pinar del Rio. He expects to be gone for several months.

C. G. Schirmer, of Boston, Mass., recently inspected the property of the Argo Reduction and Ore Purchasing Co., at Idaho Springs, Colo.

Charles F. Rand was elected president of the United Engineering Society at the annual meeting Jan. 27, Gano Dunn declining reëlection.

P. Houston has resigned as manager of the Schumacher Mine to accept the position of assistant manager at the Dome Mine, Porcupine, Ontario.

George Maitland Lazarus and Henry Thomas Long have been admitted as partners in the firm of Lewis Lazarus & Sons, London and New York.

John W. Finch, of Denver, Colo., who has been in New York for several weeks, was taken ill with typhoid fever and is now in the New York Hospital.

J. B. Tyrrell, of Toronto, Canada, will sail for England on the "Baltic" on Feb. 9. His office address will be 208 Salisbury House, London, E. C., while in England.

James Naughten, chief mechanical engineer for the North Butte Mining Co., Butte, Mont., has been in the Lake Superior district for a week, looking over mine machinery.

K. Hansen, W. Hesser Pavitt, Jr., and R. C. Jensen have opened an office at 17 Battery Pl., New York, under the name of Hansen, Pavitt & Jensen, consulting engineers for by-product coke ovens.

J. H. Plummer has resigned his position as president of the Dominion Steel Corporation on account of ill health and will take an extended holiday abroad. Mark Workman, of Montreal, has been chosen as his successor.

William H. Gallagher, assistant master mechanic for the Cleveland-Cliffs Iron Co., Ishpeming, for ten years, has resigned to become master mechanic for the Wolverine and Mohawk mines of the Stanton interests, in the Michigan copper district.

L. S. Kerchner, who has been assistant to Stuart B. Marshall in the management of the Dunbar Furnace Co., at Dunbar, Penn., has been appointed to succeed Mr. Marshall, who has gone to Whitney, N. C., to take charge of the properties of the Aluminum Co. of America there.

Mr. John D. Pope, who recently resigned from the management of the North Butte Mining Co., at Butte, Mont., has been appointed to act as consulting engineer for the Butte & Zenith City Mining Co., which is developing a promising copper property, near Nissler, about six miles west of Butte.

A. B. Apperson, formerly superintendent of the Utah lines of the Denver & Rio Grande, has been elected vice-president and general manager of the United States Fuel Co. to succeed E. L. Carpenter, recently resigned. Mr. Apperson gained his experience in coal mining when for two years he was in charge of the railroad properties of the Consolidated Fuel Co. G. E. Forrester has been made secretary and treasurer.

OBITUARY

Austin D. Mixsell died at South Bethlehem, Penn., Jan. 15, aged 42 yr. He had been connected with the Bethlehem Steel Co. for 18 yr., and last year was chosen vice-president.

Dr. Emil Holz, formerly managing director of the large steel works at Witkowitz, Austria, and an authority on mining and steel metallurgy, died recently in Berlin, Germany. He was a member of the boards of the Westphalian Steel Works and the Donnersmarck Spelter Works.

William B. Ruggles, recently engineering adviser to the Russian Government, died Jan. 23, from pneumonia, at his home at Bergen Point, N. J., aged 55 yr. He was the head of the Ruggles-Coles Engineering Co., New York, which he founded. He was born in Bath, N. Y., was graduated from Cornell, and shortly after engaged in his profession. He was the inventor of an iron-ore drier extensively used on the Mesabi Range. He was president of the Novella Cement Co. and a director of the Buffalo Potash and Cement Co. He was a member of the Engineers', Cornell, Phi Upsilon and New York Athletic clubs, and of the American Society of Mechanical Engineers. He leaves a widow and one daughter.

George Fanshawe Milliken died at his home at Flushing, N. Y., Jan. 29, aged 57 yr. He was born in New York and graduated from the Columbia School of Mines in 1879. After several years' experience at Colorado and Arizona mines he was made general manager of the Costa Rica Mining Co. In 1890 he was appointed consulting engineer for the Northern Pacific Railroad Co., and in 1896 was examining engineer for the Mines Financial Trust Syndicate, of London. From 1899 he had practiced as consulting and examining engineer, serving also at different times as manager of the Waverley Gold Mining Co. of Nova Scotia; consulting engineer for the Miller-Spier Syndicate; chief engineer of the Nevada Utah Mines and Smelting Co. He had examined many well-known mining properties and had a wide experience. He was a member of the American Institute of Mining Engineers and of the Mining and Metallurgical Society.

SOCIETIES

Northwest Mining Convention—The meeting proposed to be held Feb. 8-10, will take the form of an excursion from Spokane, Wash., to Northport, Roseland and Trail, in British Columbia.

Nevada Mine Operators Association—At a recent meeting, held in Reno, John G. Kirchen was elected president; J. W. Hutchinson, first vice-president; W. H. Blackburn, second vice-president. Henry M. Rives is secretary.

American Institute of Mining Engineers—At the meeting of the Chicago Section on Jan. 14, Dr. John A. Mathews, president Halcomb Steel Co., Syracuse, N. Y., addressed the section on "Iron in Antiquity and Today."

American Institute of Mining Engineers—The Southern California Section will meet on Feb. 1, at 6:30 p.m., in the Sierra Madre Club, Los Angeles. The feature of the evening will be the reading of a group of valuable papers on the subject announced in the program: "Petroleum; Its Geology and Technology." The contributors will be Messrs. Ralph Arnold, William F. Staunton, Robert B. Moran and W. R. Hamilton.

University of Washington—Thirty-three mining men, with experience varying from one to 25 years, have enrolled in the nineteenth annual three months' Short Session at the College of Mines, Seattle. At the annual smoker tendered the Short Session miners by the student branch of the American Institute of Mining Engineers, Captain R. H. Stretch of the Alaska Bureau, Seattle Chamber of Commerce, gave an address on "The Mineral Belts of Alaska."

American Institute of Mining Engineers—The annual meeting of the Colorado Section was held at an informal dinner at the Shirley Hotel, Denver, Jan. 7. The following officers were elected to serve during the year 1916: Chairman, L. P. Hammond; vice-chairman, F. H. Bostwick; directors, Geo. A. Kennedy and M. S. McCarthy; secretary-treasurer, P. M. McHugh. The meeting was addressed by Mr. Hammond, Mr. Bostwick and President Phillips of the Colorado School of Mines. About 50 members were present.

American Iron and Steel Institute—The Spring meet- will be held in New York May 26 and 27. At a meeting of the directors Jan. 6 in was stated that the active membership list of 1,250 has been full for some time and the associate membership list of 250 now has only eight vacancies. The directors decided not to increase the number of members in either class. Temporarily some members eligible to active membership are being elected as associate members. When that list shall have become full no more members will be elected except to fill vacancies.

American Electrochemical Society—The New York Section has arranged a symposium on "Electrochemical War Supplies," which it will hold jointly with the New York Section of the American Chemical Society and the Society of Chemical Industry at the Chemist Club, 52 East 41st St., New York, Friday evening, Feb. 11. The program will include the following speakers: Lawrence Addicks, "Electrochemical War Supplies"; W. S. Landis, "Air Saltpeter"; E. D. Ardery (U. S. Navy), "Hydrogen for Military Purposes"; Albert H. Hooker, "New War Products"; William M. Grosvenor, "Magnesium"; G. Ornstein, "Liquid Chlorine"; George W. Sargent, "Electric Steel."

Editorial Correspondence

SAN FRANCISCO—Feb. 2
(By Telegraph)

A Terrific Wind Storm at Coalinga, night of Jan. 27, destroyed 400 oil derricks and rigs, doing a total damage of about $1,500,000. On Jan. 17 wind wrecked 500 derricks in the Midway and McKittrick fields, besides two 10,000-bbl. tanks.

SAN FRANCISCO—Jan. 25

The Legal Battle for Title to Potash Lands in Searles Lake, San Bernardino County, was begun at San Bernardino in the Superior Court, Jan. 18. This particular suit was by Mrs. Ella Thompson, of New York, who has been known in the controversy as one of the Henry E. Lee locators. The defendants are the California Trona Co., the American Trona Co. and the Foreign Mines Development Co., Ltd. Plaintiff claims title to 22,000 acres in the heart of the potash lands and seeks to oust the three companies, which are practically one. The United States Land Office, having sustained the protest of Victor Barndt, president of the Railroad Valley Co., against granting patent to the California Trona Co., the attorney for Mrs. Thompson is acting upon the theory that the Court will quiet title in favor of the plaintiff in this suit. Searles Lake was located in 1908 by C. E. Dolbear and seven associates, who transferred their holdings to the present operator. In 1910 the locations were made on which Mrs. Thompson bases her case. For two years there was friction between the Henry E. Lee factions and efforts were made to jump the claims, and there was a good deal of newspaper talk about gun battles on the desert between the rival claimants. The present operators have been equipping the property and experimenting; they have built more than 30 miles of railroad, have a plant and a new town at Trona which is by automobile road about 40 mi. northeast of Randsburg.

Fire Partly Destroyed the Tungsten Plant of the Atolia Mining Co. at Atolia, San Bernardino County, on the night of Jan. 24. Fire started in the old mill and spread quickly. Bucket brigades and fire extinguishers were employed but without other result than to save neighboring buildings. This mill was the only one in operation for the reduction of tungsten ores in California, and was planned and construction begun in the last half of 1915, in the place of the old and smaller mill, to meet the requirements for treatment of a large additional tonnage of ores, not only from the company properties, but also from newly developed deposits in the Atolia and Randsburg districts. Charles Taylor, superintendent of the mine and mill, stated that the plant will be immediately rebuilt and that most of the 400 men put out of employment by the fire will soon return to work. The installation of a new hoist in place of the one destroyed in connection with the mill will not require much time, and by the time the mill is rebuilt a large accumulation of ores will be ready for treatment. The suspension of operations, however, may have the effect of discouraging development of the new deposits and the extraction of ores therefrom.

The Oil Merger Proposed to include some of the large operators in California, and known as the Pan-American Petroleum and Transport Co., is reported to be strongly objected to by some stockholders of the Union Oil company. It is stated that definite action has been started by a committee of the majority of stockholders to have the courts intercede to prevent the Union from inclusion in the merger. It is stated that $20,000 has been subscribed to back up the fight. The committee has established headquarters in the Chamber of Commerce Building, Pasadena, and early action in the courts is predicted. It is believed, however, that favorable action cannot be obtained to prevent the Stewarts' option from being exercised by the holders if they so desire. It is understood that an attempt will be made to have United Petroleum and Union Provident, the two holding companies, dissolved, and through this action the control of the Stewarts and option holders may be eliminated by the action of the majority stockholders' control. The option, it is said, will expire about the middle of February, and if the deal is not closed the option holders will forfeit $1,000,000. It is further reported that Andrew Weir, of London, who is credited with large interests in the Union, refused to allow his stock to go into the merger. This contemplated action of the stockholders will undoubtedly delay the consummation of the merger, but it is believed that it will not prevent the ultimate consummation. There are 4,500 stockholders who may dispose of their shares in exchange for stock in the new merger or receive cash if preferred at the rate of $95 per share.

Liability of a Stockholder, according to a recent decision of the California Supreme Court, is confined to debts arising from contracts which were entered into only when he was a stockholder. If he becomes a stockholder after such contract was entered into he is not liable, but the liability rests upon the individuals who were such stockholders at the time of making the contract. While this opinion was not rendered in a suit involving mining stocks, the same rule applies to stockholders of mining companies as of other industries. The opinion was written by Associate Justice Sloss. Justice Henshaw dissented, holding that such decision subverts the law as construed for the last 16 years with respect to stockholders' liability; that "liability" imparts a fixed contractual obligation in the nature of a debt upon the corporation. Justice Henshaw says that commerce demands positive fixed laws rather than inherently good laws, because it builds up its customs upon the law as written. Application of this rule of the Supreme Court to mining corporations will discourage investments in California companies dependent upon the sale of stock for purposes of exploration and development. The California Supreme Court is noted for setting up and knocking down precedents. They are usually such precedents as establish rules of law described by Justice Henshaw as inherently good rather than positively fixed laws.

DENVER—Jan. 26

More Prospectors will be scattered throughout the state next summer than for many years past, according to State Commissioner of Mines, Fred Carroll, who bases his belief upon the great number of samples sent to his department for determination. He has entered into arrangements with the School of Mines, Golden, whereby his department is cooperating with the school in assisting prospectors to identify and test their finds. At present, an average of 25 specimens and samples reach his department daily. For the most part, these represent prospects for manganese, molybdenum and tungsten.

BUTTE—Jan. 27

Montana Oil Companies Are to Be Investigated by the United States Government. The growing suspicion that advantage is being taken of the oil excitement prevailing in Butte and all over Montana by unscrupulous concerns for unloading stock seems to be so well founded that, following Butte Chamber of Commerce, the United States Government is taking steps to ascertain the status of the various companies promoting oil and natural gas enterprises. United States District Attorney B. K. Wheeler announced the other day that oil companies in Montana will soon be investigated by the Federal Government and in the event of any charges resulting they will be taken up without delay. A government inspector was sent to determine if any misuse of the mails has been going on. "Legitimate companies have nothing to fear," said Mr. Wheeler, "but those operating in defiance of established laws will be prosecuted." There are more than a dozen oil companies operating in Butte alone.

SALT LAKE CITY—Jan. 28

Business on the Salt Lake Stock and Mining Exchange continues good. The trading on Jan. 19 was the heaviest so far this year, when the total number of shares sold was 180,030, valued at $36,000.85. Trading Jan. 20 amounted to approximately $31,000.

Following the Increase in Wages by the copper and lead mines in Bingham, and on account of the rise in the price of lead and silver, four Park City mines have decided to give an increase of 25c. a day to all mine and mill employees, to go into effect Feb. 1. These mines are the Daly-Judge, Silver King Consolidated, Daly West and Ontario. The following notices were posted at these properties Jan. 23:

1. When the New York quotation of lead shall be $5.50 per hundred or over, and at the same time the price of silver 55c. an ounce or over, the wage scale shall be increased 25c. per day.

2. When lead recedes to $5 per hundred pounds and at the same time the price of silver advances to 70c. per oz. or over, the advance of 25c. per day shall continue in force.

3. When the quotations of lead and silver are less than the above, the wages shall revert to the present scale.

About 700 Miners at Park City Are Affected by the increase; there are approximately 300 at the Daly-Judge, 200 at the Silver King Consolidated, 100 at the Daly West, and 100 at the Ontario. There are 400 mine and mill employees at the Silver King Coalition, which, with the men at smaller properties, makes a total of 1,100 miners in the camp at the beginning of the year. The Silver King Coalition is considering an increase, but as yet has taken no action. Wages at Park City at present before the increase goes into effect are: Miners, car men and muckers, $3 per shift; machine men, $3.25 per shift; shaft men, $4; motor men, $3.25; mill men, $3; hoisting engineers, $4. The monthly payroll will be increased by $5,250, or approximately $63,000 a year at the new rate.

Tintic Companies Are Increasing Wages—The Chief Consolidated on Jan. 21 notified its employees of an increase of 25c. a day, this increase having gone into effect the first of January. About 300 employees, miners as well as top men, are affected. The new scale is to remain in force as long as lead is $4.50 a hundred or better, and silver 56c. an ounce or more. Later a number of other companies posted notices that the wages of miners would be increased 25c. per day on Feb. 1. Some of the companies have made the advance contingent on the price of silver remaining 55c. an ounce and lead $5.50. Other companies did not specify as to the price of the metals. The new scale on Feb. 1 will add $10,000 to the monthly payroll, and will affect from 1,300 to 1,500 men. Men employed at the different properties at the beginning of the year are as follows: Centennial-Eureka, 250; Chief Consolidated, 300; Iron Blossom, 200; Eagle & Blue Bell, 125; Grand Central and Gold Chain, 125; Gemini and Ridge & Valley, 75; Lower Mammoth, 50; May Day, 30; Yankee, 25; Dragon, 25; Beck Tunnel, 25; Opohongo, 15; total, 1,245 men at the principal mines, not including various other properties employing from two to 10 men each.

WALLACE, IDAHO—Jan. 22

One of the longest periods of cold weather in the Cœur d'Alenes in recent years has been terminated by a Chinook accompanied by snow. Operations at many of the smaller mines and at some of the larger ones were severely handicapped by cold. Interstate-Callahan and Success experienced some difficulty and Stewart was closed for a few days. The Bunker Hill & Sullivan west mill was closed for a few hours at different times, but operations were not seriously hindered. Following the cold, there were several snow-slides, one of which cut off the water-supply of Wardner and another of which is reported to have destroyed a compressor house near Mace.

The Extension of the Mining Area of the district by the development of new orebodies, which was one of the notable features of the last year, has made improved transportation facilities a necessity, and it is believed that the present year will witness the building of at least two branch lines, one on Beaver Creek and the other on Pine Creek, and the probable appearance of another transcontinental line in the district, the Chicago, Milwaukee & St. Paul. The tonnage is in sight for the two branches and there is reliable information upon which to base the prediction that the O.-W. R. & N. company will build them. The main line of the Milwaukee passes through this county along the St. Joe River, less than 20 mi. from the mines, but separated by a high divide. However, the company has a branch to Coeur d'Alene City, 50 mi. west, and indications point to the extension of this branch to the mines. In fact, this has long been regarded as the ultimate purpose of the Milwaukee, and the acquisition of the Northport smeltery by the Day interests has rendered the extension of its line to this district almost certain. The Milwaukee is already within 15 mi. of Northport and the closing of that gap and the one between this city and Cœur d'Alene would make it the most direct route between the mines and the smelting plant; giving it an advantage in hauling Hercules and Tamarack & Custer ores, which are to be treated there, as well as making it an active competitor for the other heavy tonnage of the district.

HOUGHTON, MICH.—Jan. 28

No Copper is Accumulating in the warehouses here. In fact, the metal is shipped out day by day in trainload lots. If the present shipping rate is maintained, the spring opening of navigation will see the docks bare of copper in the Lake Superior district.

At the Dollar Bay Plant of the Tamarack-Osceola and other Calumet & Hecla subsidiaries the foundation for the new furnace is completed and steel is on the way. This new furnace with the new one under construction at Hubbell puts the Calumet & Hecla people in position to handle an unusual capacity of mill product. Calumet & Hecla's output of silver is maintained steadily and is becoming quite a factor in the earnings of this company. The silver now is coming mostly from the lower levels.

Nothing More is Heard of the Proposal to consolidate the Tamarack and the Calumet & Hecla, and the presumption is that the scheme has been dropped temporarily at least. W. E. Parnall, at one time manager of the Tamarack and other of the then Bigelow mines, made an extended examination of the property last summer by direction of the Tamarack board of directors. He presented his inventory to the directors and no public statement of its contents was given out. It is understood that Mr. Parnall made no recommendations as to the market value of the stock.

Ahmeek Will Have Eight Stamp Heads in operation by July 1 unless there are unforeseen hindrances in the delivery of machinery. The construction of the two heads is going forward with all possible rapidity. At the present time six heads are in operation. Ahmeek is a young mine not yet reached the zenith of its production. It has assurances of better than 20 lb. of refined return on the rock for at least 10 years to come, and is now actually showing better than 24 lb. It has shafts that can go to greater depths than any in operation in the district.

At the Winona Mine there has not, as yet, been any appreciable increase in the output of copper. Even with the limited production there is a profit in operations at the present time, but costs are close to 16c. The officials of the corporation are satisfied that the future of the Winona property depends upon the development of the flotation process or some other efficacious process for saving the fine particles of copper. The Winona formation is quite unlike any other copper formation in this district and requires a peculiar treatment. There is every hope that the present experiments will work out satisfactorily.

PHILADELPHIA—Jan. 29

W. W. Winchester, secretary of the Peruvian Potash and Chemical Co., with offices in the Widener Building, asserts that his company owns 3,000 acres of surface potash deposits in southern Peru which can be mined with a steam shovel. The crude salt is said to carry about 46% of KCl.

MORENCI, ARIZ.—Jan. 26

Everybody Is Happy in Morenci Today. The whistles were blown this morning for the first time in over four months. Managers of the Arizona Copper Co. and the Detroit Copper Mining Co. had notices posted yesterday to the effect that their offices would be open today for the purpose of receiving applications for work. Every man in Morenci reported for duty this morning and as many as could be used were taken on, while others were told to report from day to day. As a general thing, the mines were found in about as good condition as they were when the strike was called, and it is thought that something like the normal output will be attained by Feb. 1. A few levels are flooded, but most places are dry and ready for ore to be shoveled into the chute. Mules and horses are expected tomorrow from Safford, and wheels are expected to turn immediately thereafter. It develops that the strike was not supported by the Western Federation. Most of the help came from miners in the state; Miami contributing about $12,000, or over half of the total donations. The settlement came when the strikers voted to accept the managers' proposition to extend the present sliding scale to include 24c. copper instead of stopping at 20c. The managers declare that, since the Western Federation is out of it, they will deal with the men in a broad spirit. They predict that the Clifton-Morenci-Metcalf district will promptly resume its place among the most prosperous districts in the state.

MONTEREY, MEXICO—Jan. 17

American Mining Men in Mexico who are familiar with the situation in the different mineral districts of the country say that the new tax of 12 pesos per pertenencia will have a disastrous effect upon the industry, particularly with the many thousands of claims that are held for speculative purposes. The statistics of the government show that there are at this time approximately 430,000 legal mining claims in Mexico. Under the Diaz regime these claims gave the government an annual net tax revenue of about two million pesos. While it is the purpose of the increased tax to greatly increase the Federal revenue, it is claimed by mining men that it will have the opposite effect for the reason that perhaps 90% of the existing claims will be abandoned on account of inability or impracticability of the owners to meet the increased tax. Formal protest has been made to "First Chief" Venustiano Carranza by mining men against the new tax, and hopes are entertained that he will reduce the figures to such an extent as to protect the many thousands of claims that are in the hands of comparatively poor men who are seeking to interest capital in their development.

The Mining News

ARIZONA

Gila County

MIAMI COPPER (Miami)—In 1915 produced 41,000,000 lb. of copper against 33,296,010 lb. in 1914. Cost of production was 8½c. per lb. against 9.2c. per lb. year previous. Production for January close to 4,400,000 lb., or at rate of 53,000,000 lb. per year.

ASBESTOS (Globe)—Claims of Will Shanley have been bonded by E. Shafe Reigelman and associates, of New York. Property consists of two groups of 35 claims adjoining property of Arizona Asbestos Association on Ash Creek. It is understood New York syndicate is well financed and work on large scale will soon commence.

OLD DOMINION (Globe)—Now hoisting 1,000 tons daily from 12th, 14th and 16th levels on east and west sides and from 15th level on west side only. Encouraging development work is being done on 17th and 18th levels. "A" shaft sump will be deepened so as to accommodate 3-deck cage at 18th level; all ore is hoisted through "A" shaft. Work has been started on outlying Darius claim; Grey mine is being developed with most satisfactory results. Thickening tank and second filter unit being added to concentrator; extra settling tanks being built along Final Creek; mill treating about 700 to 800 tons ore daily. There is local talk of consolidation of the Old Dominion and Arizona Commercial Copper. Merger would lessen cost of development in both mines.

Mohave County

PASADENA BOY (Kingman)—Controlling interest has been purchased by Edward Grady, representing parties, of Bakersfield, Calif.

TIMES MINING (Oatman)—Large interest acquired by Charles E. Knox, of Berkeley, Calif., general manager of Montana Tonopah mine, at Tonopah, Nev., and Ben S. Revett, of New York. At stockholders' meeting soon to be held in Oatman, capitalization will be increased from million to million and a half shares of par value of $1 each.

Pima County

ATLAS (Silverbell)—Will increase shipments from 50 to 100 tons daily soon as shipping facilities on Arizona Southern Ry. are available.

MINERAL HILL (Silverbell)—Operating under lease from E. N. Barnsdale, of Pittsburgh, controlling owner, E. M. Ray, is shipping from 75 to 100 tons daily; force of 90 men will soon be augmented.

AMERICAN SMELTING AND REFINING (Twin Buttes)—Is doing development work on Bush-Baxter property and is sinking shaft on 3 Nations group. Is shipping 14 cars weekly from Minnie.

GLANCE (Twin Buttes)—E. C. Bush has finished unwatering shaft and has begun drilling in bottom. His associates are J. W. Baxter, of Tucson, and Charles F. Pfister and James Rickerson, of Milwaukee.

U. S. VANADIUM DEVELOPMENT (Kelvin)—New corporation organized to take over group of 13 claims in Riverside district from J. Jay Sullivan. Consideration $30,000 and 750,000 shares in new company. Mr. Sullivan has been developing property for several years, which was originally owned by O. W. Plath, J. W. Foss and Peter Mohn, of Phoenix.

Yavapai County

CHAMPION (Prescott)—G. G. Lemmon, consulting engineer of British syndicate that recently purchased Champion mine in Crook Canyon, has arrived and is preparing to develop property on large scale. A 50-ton mill, equipped with a flotation section, will be built and other improvements made.

CALIFORNIA

Amador County

TREASURE (Amador City)—Some of the men have been laid off temporarily and others kept on development work. Installation of mill is contemplated.

SOUTH EUREKA (Sutter Creek)—The 80-stamp mill in constant operation. About 250 men employed, including men unwatering the Oneida and preparing for reopening. W. H. Schmal is superintendent of both properties and Henry Malloch, of San Francisco is general manager.

BUNKER HILL (Amador City)—Regular monthly dividend of 2½c. per share distributed, making 115 consecutive monthly dividends paid. Mine is in good condition; some of best ore comes from 2,400 level; 40-stamp mill in constant operation. E. Hampton is superintendent.

Calaveras County

NUNER (Mokelumne)—Property bonded and operation will be resumed. It is situated on Stockton Hill channel and was formerly producer.

AMADOR CITY (San Andreas)—Property situated in Chile gulch recently bonded to Los Angeles Mining and Development Co. Development will begin immediately.

BOSTON (San Andreas)—Reopening after several years of idleness is contemplated. Property is developed to depth of 900 ft. and about 1,200 ft. of drifts. Stated that enough ore is in sight to supply a large mill tonnage.

UTICA (Angeles Camp)—Reported mining operations will continue with reduction of about 50 underground men. About 8,000 tons of ore ready for mill. After cleanup of this milling, crew will work deepening winze, in hope of striking Gold Cliff lode. If Gold Cliff extends to Utica, a greater mine is assured. If not, operations may be abandoned. Winze will have to be deepened about 300 ft. Utica has operated successfully for more than 30 years.

Eldorado County

MINES ELECTRICALLY OPERATED with power from Western States Gas and Electric Co. have not been troubled by recent storms. Only one mine in county was shut down, on account of trouble with ditch which supplies water for Poverty Point. Rumors in California newspapers to effect that all mines in vicinity of Placerville were shut down and other extraordinary statements were untrue.

Kern County

G. B. (Randsburg)—Two leasers are operating a jig near this mine in the Stringer district, making 30 to 50 lb. of tungsten concentrates per day; said to run 60%.

Nevada County

EMPIRE (Grass Valley)—Big reduction plant was closed down on Jan. 12 for lack of water due to the snow blockade in the Cascade ditch. Underground work was undisturbed. Other plants also put out of commission until the ditches can be cleared.

QUEEN REGENT (Spencerville)—Arrangements made for immediate installation of reduction plant to treat the copper-gold ores produced in this mine, a large tonnage of which is blocked out. Ore reported to assay from $12 to $20 per ton. It is old property, but was never large producer in earlier days, although under proper management mine has paid.

LE DUC (Glass Valley)—At annual meeting of directors and stockholders was decided to continue development and operation. J. P. Jones, of San Francisco, elected president, and Dr. W. G. Thomas, of Grass Valley, secretary. B. A. Penhall was reappointed manager. More than 3,400 ft. of tunnels have been driven, which have cut several ledges, but the pay shoot or orebody has not been disclosed. Company has spent about $40,000 in development and expects to continue until successful.

Placer County

GREY EAGLE (Forest Hill)—Final payment on North Star property, involving status of Grey Eagle, has been made by W. A. Fitch to W. F. Russell interests, through Sheriff McAuly. Development of property and installation of electrically driven machinery is in progress. Relocations and threatened law suits have not obstructed progress. Property was sold under contract for total of $14,000, payable in monthly installments of $1,000 each.

Shasta County

EVENING STAR (Redding)—George Bayha has purchased this mine in Old Diggings at sheriff's sale for $5,000. Bayha was for several years manager of mine. It is one of oldest in district and bears evidence of making permanent producer.

Siskiyou County

CLASSIC HILL (Happy Camp)—C. S. Greening is making preparations for resuming operation now that an abundance of water is assured. Formation is decomposed quartz which contains large pockets of gold-bearing ground. Property is owned by Los Angeles men.

Trinity County

YUKON GOLD (Carrville)—This company, of 120 Broadway, New York, has leased the properties of the Trinity Development Co. and has placed orders for the construction of a 9-cu.ft. all-steel dredge.

COLORADO

Boulder County

BOULDER TUNGSTEN (Boulder)—The 35-ton concentrating mill has been completed and adjusted and is now in successful operation. Contract for this plant was let to the Colorado Iron Works Co., of Denver, Colo., on Oct. 15, and the finished mill was turned over and paid for on Jan. 17. New plant represents an investment of about $20,000. Company now owns Forest Home, 1905, Dillon, Midnight, Nancy Henderson and Gold Ribbon mines. Estimated that about 10,000 tons of milling ore are available in these properties at present time. All ore now being delivered to new mill is coming from Forest Home property. Development work now in progress on veins opened by main tunnel. Company is in market for tungsten ores. J. G. Clark is manager.

Clear Creek County

TREASURE VAULT (Idaho Springs)—West drift on Edgardine vein on 120 level has opened 2-ft. vein of ore, assaying 0.88 oz. gold and 53 oz. silver per ton. Drift will probably cut Treasure Vault vein within 100 ft.

Gilpin County

AVONDALE LEASING (Idaho Springs)—Will undertake development of Avondale property through Newhouse tunnel. East drift on Sunflower vein, which has opened a 3-ft. vein of $8 ore, will be advanced to intersect Avondale vein, whereupon drifting will continue on latter vein. The company plans to ship its ore to Argo mill for treatment.

Ouray County

CAMP BIRD (Ouray)—Ore crushed in December, 2,468 tons; estimated profit, £8,930.

San Juan County

PARKER (Silverton)—This Tower Mt. property is being developed under direction of John Meager. At distance of 300 ft. from portal of main crosscut tunnel 12-ft. vein of good ore has been cut at depth of 100 ft. from surface. Vein contains copper sulphides carrying gold and silver. Samples selected from more promising streaks in vein indicate from 0.4 to 1 oz. gold, 25 to 50 oz. silver, and 15 to 20% copper.

KITTIMAC (Silverton)—At point 150 ft. from breast of east tunnel drift has been advanced on what is supposed to be Isabella vein. A 3-ft. vein of promising sulphide ore has been opened carrying gold and silver. West workings on Clark vein have opened payable ore. Recent flotation tests on gold and silver ore from Little Joe vein indicated recovery of 95%. Development will be resumed on this vein. New ball mill has been installed and mill will be ready to start in near future. Mr. Walter is manager of mine and Mr. Card is superintendent of mill.

San Miguel County

CARBONERO (Ophir)—Four men recently engaged in development work in the Shoofly tunnel were killed on Jan. 10 by a snowslide in Carbonero Gulch.

BLACK BEAR (Telluride)—Recent development work has been highly encouraging. An 8-ft. vein of $6 ore has been opened. Property is now producing 100 tons of milling ore per day, which is trammed to Smuggler-Union mills for treatment.

Teller County

JEFFERSON (Victor)—Foundations being laid for three-drill Ingersoll-Rand electrically driven air compressor and timbermen are at work repairing shaft. Considerable new development work has been planned. Shaft to be sunk to depth of 1,000 ft. Property has been secured under long-time lease with option to purchase by M. B. Burke, of Denver. Charles Bender is superintendent.

GOLD PINNACLE GOLD (Victor)—Extensive development planned at this Bull Hill property by Ecton, Hildebrand & Co. New air line aggregating 2,500 ft. laid from Mitchell shaft and machine drills are being installed. Air line connects with main line of Teller County Air Co. near Empire State shaft of Isabella Mines Co. At depth of 600 ft. Mitchell shaft entered oreshoot on northwesterly vein dipping northeast and lying parallel to main Pinnacle vein. Trial shipments are being made from ore mined during development.

IDAHO

Shoshone County

HECLA (Wallace)—Development on parallel vein reported to show oreshoot 800 ft. long to depth of 1,200 ft.

ALICE (Wallace)—Property bonded to G. A. Collins and associates, of Seattle, who plan to commence active work about Mar. 1. Property consists of 20 patented claims on Ruddy Gulch, between Wallace and Mullan and mile from N. P. railway tracks. Has production record of about $180,000. Two parallel veins, one developed by 600-ft. shaft. Equipment includes compressor, hoist, and 150-ton mill.

NATIONAL (Mullan)—Recent shipments of concentrates from National, at rate of 4 cars monthly, reported to net company $90 per ton. Mill is run one shift, mainly on account of inability of mine to supply sufficient ore of milling grade for continuous operation. Developments on lowest level, the 1,200, said to indicate ore is becoming richer as depth is gained, and management is considering driving of 8,000-ft. crosscut to cut vein far below present workings.

LITTLE PITTSBURG (Kellogg)—J. D. Beebe, manager of Colonial Mining Co., which has bond on Little Pittsburg on Pine Creek, reports 300-ton mill practically completed. Ground was broken for mill on Dec. 12; construction involved hauling all lumber and machinery 8 mi. from railroad. This is a record time for mill construction in this district. A large body of zinc and lead ore, the former predominating, is being rapidly developed, about 2 ft. of which is high-grade zinc that will be shipped crude.

EMPIRE (Enaville)—Owns property formerly known as Horst-Powell, on Little North Fork, is assembling machinery for concentrating mill which will include flotation. Mill building rapidly nearing completion; expected will be in operation early in spring. Electric power line being extended for both mill and compressor. Mine is developed by series of tunnels and two shafts from lower one each 100 ft. deep, blocking out large tonnage of copper ore. Mine 5 mi. from railroad will probably be connected by branch line this summer.

MICHIGAN

Iron

SECTION 16 (Ishpeming)—New steam pumping plant about ready to go in commission. Is considered one of finest in district.

TRADERS (Iron Mountain)—Contract will be let to strip 75,000 cu.yd. from orebody at north end of pit. This will bring mine close to line of old Cornell. Will be heavy shipper this year.

MINNESOTA

Duluth

ZENITH FURNACE (Duluth)—Improvements to coal docks have been started by Barnett & Record, contractors. Will cost $100,000; being 300-ft. extension, which will increase capacity 125,000 tons. Coal-handling facilities are also being rearranged.

DULUTH & IRON RANGE RY. (Two Harbors)—Substantial changes being made in the company's electric power plant. New boilers, stack, air compressor and turbine engine will be installed. Made necessary account of increased use of electricity at their ore docks.

MINNESOTA STEEL (Duluth)—Inclement weather delayed blowing in of second blast furnace. On Jan. 1, employees at plant numbered 1,735, exclusive of 75 in general offices. In this total are represented 33 races, although over 40% of the total is American born. Percentage of American born is highest in all departments except common labor.

Mesabi Range

FOWLER (Aurora)—Hoisting of ore has been started. Sixty men are employed.

SHENANGO (Chisholm)—Mine has been idle for 10 days. Old wooden headframe being replaced by new one of steel.

TIOGA (Chisholm)—Headframe now in place. Shaft sinking completed. Drifts being extended to orebody. Work on timber shaft will be deferred until spring.

GLEN (Chisholm)—Electric haulage system now in good working order. More mining can now be carried on underground. Fifty-one gangs are at work. This is an increase of 12.

SHIRAS (Buhl)—Regular shipments now being made to Duluth steel plant. Additions being made to change houses at Shiras, Wanless and Deacon mines; large forces are now being employed at all properties.

WAGE ADVANCE—At a meeting of the independent mine operators of the Mesabi Range, held at Virginia, Minn., Jan. 25, it was decided to grant 10% advance, effective Feb. 1. Move made necessary on account of similar action on part of Steel Corporation.

Vermilion Range

SOUTH CHANDLER (Ely)—Fire on Jan. 25 destroyed part of shaft house. This, however, did not interfere with underground operations.

MONTANA

Lewis & Clark County

BUTTE & HELENA WHITLACH GOLD MINING CO.—Recently organized to reopen Whitlach group of claims, famous old gold producers, located at Unionville and Park City, about 5 mi. south of Helena. Properties consist of six full claims, all of which have been worked. Immense flow of water encountered in many of claims in most cases stopped further operations. New company is preparing to equip property for extensive mining and to take care of all water that may be encountered in future.

Silver Bow County

BARNES-KING (Butte)—First two weeks of January broke all previous records in production.

BUTTE-NEW YORK (Butte)—At this property, adjoining and developed under contract by Butte & Superior, Col. Sellers vein on 1,200 level was reached early in December and has since been drifted on; vein promises to develop a good body of zinc ore.

PILOT-BUTTE (Butte)—Persistent reports current that Anaconda company has made an offer for purchase of Pilot mine, and that Pilot-Butte company is willing to sell, but officers and stockholders have not yet been able to agree on price they should receive.

BULLWHACKER (Butte)—Butte syndicate that secured lease on Bullwhacker mine has been unable to get any smelter rates and expected operations at property have been postponed indefinitely. Members of syndicate now figuring on treating ore by leaching process.

BUTTE-DULUTH (Butte)—Leaky telegraph wire spilled code message in Butte, relating to Elm Orlu-Butte & Superior decision in Federal Court and wild story was circulated and sent broadcast to effect that Anaconda company had purchased Butte-Duluth property. There is no change in affairs of Butte-Duluth.

DAVIS-DALY (Butte)—Work of completing three-compartment shaft at Colorado nearing completion; after Feb. 1 company will have use of it down to 2,500 level. This will increase output materially. Grade of ore continues to average 7% copper. Management is securing bids for new hoisting and other machinery, recently recommended by Secretary Schirmer.

NORTH BUTTE (Butte)—Company's failure to advance dividend, same as other Butte companies, is explained by increased cost of producing copper during past year. For only last three months of 1915 company operated at normal capacity. During the year change of hoisting from Speculator to Granite Mountain shaft required connections to be made on all levels between the two shafts. Cost of such work was of unusual nature. With smaller production and the above extraordinary expenses, cost of production per pound of copper was materially increased during 1915. How much has not been made known.

BUTTE & SUPERIOR (Butte)—Two new shafts started by company some time ago are being rushed at record speed. They are to be three-compartment shafts and will be worked from surface down and from several levels below by raising. Both shafts will be ready for use by end of 1916. They will be connected on all levels with Black Rock and will put company in independent position in case of accident to one shaft. According to statement of operations in company's oil-flotation plant, filed in Federal Court Jan. 20, during December 10,409 tons of concentrates valued at $86 a ton were made in the plant from 45,277 tons of ore treated, at a cost of $2.93.

NEVADA

Elko County

ELKO PRINCE (Gold Circle)—New cyanide mill, designed for 60 tons per day, now operating, having made its first run Dec. 13. Complete sampler is to be installed later for handling of custom ores.

Humboldt County

WINNEMUCCA MOUNTAIN (Winnemucca)—Mill is now in course of construction and will be put in operation in about 60 or 90 days.

PACKARD EXTENSION (Lovelock)—Company recently organized by local mining men to develop ground, consisting of four and a fraction claims, lying south and west of Nevada Packard mines. Capitalization, 1,250,000 shares; par value of $1.

NEVADA PACKARD (Lovelock)—New cyanide mill, which started treating ore Dec. 1, made initial shipment of 1,400 lb. of precipitate, valued at $8,300. Value of ore mainly in silver occurring as chloride. Gold is free. Claim 98% extraction with treatment cost of about $2 per ton.

ROCHESTER MINES (Rochester)—Mill completed in April, ran 203 days during 1915, treating 23,090 tons, or 113.7 tons per day. Bullion recovered amounted to 3,131.5 oz. gold and 545,959 oz. silver, valued at $332,818. Heavy snow fall middle of January resulted in a four-day tieup of the Nevada Northern R.R., which transports ore to company mill. Recent strike was in Colligan workings on Weaver No. 2 claim, 4 ft. of $70 ore being reported.

Nye County

TONOPAH ORE PRODUCTION for week ended Jan. 22 was 8,520 tons, valued at $178,620, compared with 8,597 tons for week previous. Producers were: Tonopah Belmont, 2,854 tons; Tonopah Extension, 1,850; Tonopah Mining, 1,750; Jim Butler, 1,100; West End, 705; North Star, 52; miscellaneous leases, 209 tons.

TONOPAH BELMONT (Tonopah)—December production was 12,706 tons with a net value of $154,469. Net profit was $80,135 compared with a profit of $64,535 for November. Increase largely due to rise in price of silver.

REORGANIZED WHITE CAPS MINING (Manhattan)—Company is reorganization of the White Caps Mining Co. Development of property, which has been resumed, will include sinking main shaft an additional 100 ft.

JIM BUTLER (Tonopah)—December production, 3,981 tons; net profit, $22,005. Ore is treated by Belmont Milling Co. at Millers under contract calling for full payment for bullion recovered, less treatment charge of actual cost plus 5%.

UMATILLA-TONOPAH (Tonopah)—Diamond-drill core at depth of 1,736 ft. to 1,762 ft. below surface yielded assays from $1 to $7 per ton. Formation stated to be trachyte. Hole being enlarged and will be continued. Drilling from bottom or 1,200 level.

TONOPAH MINING (Tonopah)—During December 12,225 dry tons were produced; average value $12.45 per ton. Bullion recovered, $139,700, from which net profit was $56,025. It is stated a party of company officials, including President Austin, Vice-President Spurr, Director Charles R. Miller and Superintendent Blackburn will leave early in February for a visit to Nicaragua, where Eden Mining Co., subsidiary company, is operating.

Storey County

CON. VIRGINIA AND OPHIR (Virginia)—West crosscut 2,700 level advanced to 290-ft. point, passing through favorable vein formation carrying stringers of quartz.

OPHIR (Virginia)—Central tunnel work interfered with by storm; repair work done only one day. Extracted 80 cars of ore and 105 tons crushed. Preceding week 220 tons crushed.

CROWN POINT-BELCHER (Gold Hill)—Extracted from No. 2 stope 1,600 level, 424 cars of mill rock and 355 tons sent to gloryhole from shaft bins. Water held 65 ft. below 1,600 level.

SIERRA NEVADA (Virginia)—Raise in old stope 2,400 level in good ore; 4 ft. averaging $39 per ton; 52 tons saved, averaging $13.19. Winze in No. 1 stope, 2,500 level, shows $20 ore in bottom; 56 tons saved, averaging $21.76; west crosscut in vein matter and clay.

UNION (Virginia)—Shaft reopened to the 105-ft. point below the 2,000 level. Extracted 257 tons of ore which yielded about $5,000, as follows: 2,500 level, No. 2 stope, 166 tons, averaging $27.34; No. 3 stope, 124 tons, $11.98; 2,400 level, No. 4 stope, 17 tons, $14.10. Preparing to stope on 2,500 level.

MEXICAN (Virginia)—Some improvement on 2,700 level, No. 4 east crosscut advancing through porphyry and stringers of quartz of low assay; 2,500 level, west crosscut No. 2 in porphyry and quartz of low assay. Mexican mill crushed 415 tons custom ore averaging $19.63, and yielding gross about $8,000. Mill shut down one day.

SOUTH DAKOTA

Lawrence County

MONARCH (Deadwood)—Mine has been given over to leasers, who are putting it in shape for shipments to the smelters.

HOMESTAKE (Lead)—New hoist, new boiler plant and new generating plant are nearly completed and will be in operation within 90 days. Hoist with surface arrangement for handling mine product will greatly reduce costs. Second car of tungsten ore is being taken out for shipment.

UTAH

Beaver County

PALOMA (Milford)—Company is loading its first car of ore. Sinking is to be continued to 500 level before much ore is mined.

Piute County

MINERAL PRODUCTS (Marysvale)—First car of alumina has been shipped from this company's plant. Material is obtained as byproduct in treating alunite for recovery of potash, and is unusually pure. Output of potassium sulphate is now between 25 and 30 tons daily.

Salt Lake County

ALBION (Alta)—Five feet of copper-silver ore reported in raise from Quincy level on Conner fissure.

SOUTH HECLA EXTENSION (Alta)—This company has been incorporated for purpose of developing claims in neighborhood of South Hecla, Cottonwood, Atlantis and Peruvian properties in Little Cottonwood. Capitalization is 1,000,000 shares, par value 10c. Ground covers about 40 acres. G. H. Watson is president and Herman Bamberger, E. Mills Storer, D. W. Harcrow, H. C. Edwards, directors. Two fissures showing some ore have been opened by shallow shafts.

UTAH POWER AND LIGHT (Salt Lake)—This company furnishes current for lighting and miscellaneous service to many communities, and also large amount of power under contract to mining and smelting interests, including Utah Copper, United States Smelting, the American Smelting and Refining, beside other industrial concerns such as Union Portland Cement Co., Portland-Ogden Cement, Portland Cement Co. of Utah, Salt Lake Pressed Brick, Utah Lake Irrigation, Mosida Irrigation, Salt Lake & Ogden railway and the Salt Lake & Utah railroad (Bamberger and Orem lines).

UTAH METAL AND TUNNEL (Bingham)—December earnings amounted to $108,000, of which $58,000 came from Utah Metal ground and $50,000 from Bingham-New Haven. Gross receipts were $148,000. Large cash surplus on hand. Bingham Metal ores can now be transported over Bingham-New Haven aërial tram, reducing transportation costs by 50c. a ton, and making increased production possible. Planned to increase capacity of mill to 200 tons daily and to install flotation plant. Crosscutting will be done from Bingham-New Haven to get under orebodies opened in Utah-Metal section 75 ft. above tunnel. This work will be 300 ft. below Bingham-McGraw tunnel level. New orebody opened in Bingham-New Haven has been followed 170 ft. It averages 3% copper or over.

Summit County

SHIPMENTS FROM PARK CITY for the week ended Jan. 21 amounted to 1,410 tons, valued at $56,000, four properties shipping.

BIG FOUR EXPLORATION (Park City)—Company's mill at Atkinson below Park City has suspended operations for winter, owing to cold weather.

SNAKE CREEK TUNNEL (Park City)—In December face was advanced 341 ft., last 50 ft. having been in diorite. On Jan. 2, flow of water was 19 sec.-ft. Present length is 13,721 ft.

ONTARIO SILVER (Park City)—About 100 men working at this property, 50 on company account and 50 as leasers. N. W. Dunyon has been made general manager. Active development on company account will be started soon.

Tooele County

INTERNATIONAL SMELTING (Tooele)—It is understood that Cottrell system for removal of solids from smelter fume is to be installed at International smeltery at Tooele. Experiments have been in progress for year and a half to determine efficiency of system and its application to problems of International. Enough Cottrell units are to be installed to handle all of fumes from sintering plant.

Utah County

THERE IS ABOUT 7 FT. OF SNOW in the upper part of American Fork Cañon. Development is being done at Texan, Dutchman, Bay State and Pacific properties here.

PACIFIC (American Fork)—Lower tunnel has been driven 250 ft. beyond point where connection was made with upper workings. Much of this work has been in ore in mineralized ground. New raise being driven for ventilation. Car of lead-silver ore is ready for shipment.

CANADA

Ontario

ORE SHIPMENTS OVER THE T. & N. O. RY. for the month of December, 1915, in tons of 2,000 lb., were from Cobalt proper: Beaver, 31 tons; Buffalo, 62; Cobalt Comet, 63; Conisagas, 61; Crown Reserve, 99; Kerr Lake, 87; La Rose, 174; McKinley-Darragh, 73; Mining Corporation of Canada, 364; Nipissing, 61; O'Brien, 47; Penn Canadian, 34; Peterson Lake-Seneca Superior, 104; Right-of-Way, 42; Silver Queen, 19; Temiskaming, 28; from New Liskeard, Casey Cobalt, 24; from Elk Lake, Miller Lake O'Brien, 24; total silver-ore shipments, 1,406 tons. From Schumacher, Porcupine Vipond (gold), 1.3 tons; from Porquis Junction, Alexo Mine (nickel), 1,283 tons.

HOLLINGER (Timmins)—The 4-weekly statement for period ended Dec. 31 shows gross profits of $220,080 from treatment of 29,947 tons of ore; average value, $10.37 per ton; working cost, $3.18 per ton milled. Mill also treated 11,591 tons of ore from Acme.

TOUGH OAKES (Kirkland Lake)—At annual meeting an entirely new board of directors was elected with Mr. Harry Oakes president. Election will probably result in litigation as old board claims that there were not enough proxies to represent quorum. Large amount of stock is tied up in English courts. Company owns mine of promise, and has been brought into disrepute through methods of financing.

CROWN-RESERVE (Cobalt)—Complaints of the shareholders regarding the non-payment of dividends were met with the statement that the dissatisfied shareholders had better sell their stock. Annual statement showed net profits of only $13,286 from Crown-Reserve, while dividends from Porcupine Crown brought total to $191,814. Year's surplus was $27,178, after paying $106,129 in dividends. Total surplus amounts to $793,938. The company paid 6% in 1915, 24% in 1914, 45% in 1913 and 60% in 1912.

QUEBEC

CONSOLIDATED MINING AND SMELTING CO. OF CANADA (Montreal)—This company has increased its capital stock from $7,500,000 to $15,000,000.

MEXICO

Hidalgo

SANTA GERTRUDIS (Pachuca)—Ore crushed in December, 19,841 tons; estimated profit, £13,786.

Sonora

BELEN MINE (Cumpas)—About 5 tons ore per day being shipped. Leaser on this mine has worked all through trouble and has been shipping ore all the time. Ore runs about $50 per ton.

NACOZARI CON. COPPER (Nacozari)—Another car of high-grade ore is being loaded for shipment to El Paso. This ore is much better grade than previous cars; will average about $200 per ton.

MOCTEZUMA COPPER (Nacozari)—Mine and mill have again resumed operations at full capacity; milling about 2,500 tons of ore daily. Laborers are paid upon a silver basis in American money; value of one peso being 40c. gold.

The Market Report

Metal Markets

NEW YORK—Feb. 2, 1916

The special features last week were the continued strength in copper and lead, a quiet and stationary market in tin, and rather chaotic conditions in spelter.

Our tables this week give prices for seven days, the day omitted last week being given in its place.

Copper, Tin, Lead and Zinc

Copper—In this week's issue, we report the stock of refined copper held by the refiners at their works and in warehouses and elsewhere on Jan. 1, 1916, as having been 84,660,380 lb. The behavior of the market since Jan. 1, and especially during the last week, indicates that the stock must have been very greatly reduced since Jan. 1. This is especially evinced by the premiums that have had to be paid for near-by (February and March) copper, as high as 25⅝c., net cash, New York, having been paid for round lots. The major market during the last week, as in the previous week, was for April-May-June delivery.

Some of the producers have disposed of all the copper they expect to make up to the middle of the year, and are out of the market except for later deliveries. Others are able to supply only a little copper for June delivery. This put the market chiefly in the hands of those who could supply April and May copper, and led to a further stiffening of price, 25½c., regular terms, equivalent to 25¼c., net cash, New York, being the prevailing price. Some business in copper further ahead was done at a little less, while near-by copper fetched a premium in some cases, as previously noted. However, those producers who had any prompt copper supplied their regular customers with it at the prevailing price of the major market.

In the early part of our week of record, some rather large domestic business was done. In the latter part there was less. The business with Europe was not apparently quite so large as in the previous week. Some domestic consumers appear to have failed to cover their requirements for near-by copper. It is evident that the situation in the copper market is becoming decidedly tight.

Copper Sheets are quoted at 32c. per lb. for hot rolled and 33c. for cold rolled. Copper wire is 26½@26¾c. per lb. at mill.

Tin—But relatively little business was done, and the market was steady and uninteresting throughout the week.

Shipments of Bolivian tin ore and concentrates from West Coast ports in 1915 are reported as equivalent to 20,363 tons tin; a decrease of 614 tons from 1914. Shipments to New York were equivalent to 356 tons tin.

Lead—There was a large foreign demand, and some heavy transactions for export, which realized very fine prices. The domestic demand was light. The principal producers continued to supply their regular customers at 6.10c., New York, and at 6.02½c., St. Louis.

Spelter—A rather large business was done, especially for April-May-June delivery, which was in the main taken at 15½c. There was a smaller volume of business for February-March-April and March-April-May, business for those months being done in round lots at about 17c. Prompt spelter was generally available at about 18½c., but on some special business upward of 19c. was paid. In fact, the spelter market was rather at sixes and sevens, prices varying widely on business done for the same delivery on the same day, especially in the case of spelter that was wanted on this side of April. The outstanding feature of the market was the ability of producers for the first time in a long while to sell freely for second-quarter delivery. There was a good volume of domestic business, and also there were large sales for export. Incidentally it may be noted that there is believed to be a large quantity of spelter, previously held for export, now piled up at the seaports awaiting shipping facilities.

Zinc Sheets—Demand is good and sales are steady. The base price is unchanged at $24 per 100 lb., f.o.b. Penn., Ill., less 8% discount.

Imports and Exports of the Minor Metals in the United States 10 months ended Oct. 31, in pounds, except platinum, which is in ounces:

	Imports		Exports	
	1914	1915	1914	1915
Nickel	30,067,264	44,139,826	24,589,972	23,373,568
Antimony	12,829,079	15,943,501	1,310,328	2,316,752
Aluminum	14,398,031	7,561,357	18,932	40,109
Quicksilver	.....	.....	28,230	217,039
Platinum	66,544	32,615	143	9

Nickel and antimony include contents of ore, matte, etc. In addition to the quantities given above manufactures of aluminum were exported valued at $1,203,540 in 1914 and $293,944 in 1915. Exports include reëxports of foreign material.

DAILY PRICES OF METALS IN NEW YORK

Jan. Feb.	Sterling Exchange	Silver, Cts. per Oz.	Copper Electrolytic, Cts. per Lb.	Tin Spot, Cts. per Lb.	Lead New York, Cts. per Lb.	Lead St. Louis, Cts. per Lb.	Zinc St. Louis, Cts. per Lb.
			25			6.00	16.50
26	4.7600	57	@25¼	41¾	6.10	@6.02½	@18.50
			25			6.00	16.00
27	4.7619	56⅞	@25¼	41¾	6 10	@6.02½	@18.50
			25			6.00	16.00
28	4.7613	57⅛	@25¼	41¾	6 10	@6.02½	@18.50
			25			6.00	15.50
29	4.7625	56⅞	@25¼	41¾	6 10	@6.02½	@18.50
			25			6.00	15.50
31	4.7600	57⅛	@25¼	41¾	6.10	@6.02½	@18.50
			25			6.00	15.50
1	4.7600	56⅞	@25¼	41¾	6.10	@6.02½	@18.50
			25			6.00	15.50
2	4.7538	56⅞	@25¼	41¾	6.10	@6.02½	@18.50

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

Jan.-Feb.	Silver	Copper Standard Spot	Copper Standard 3 Mos.	Copper Electrolytic £ per Ton	Copper Electrolytic Cts. per Lb.	Tin Spot	Tin 3 Mos.	Lead £ per Ton	Lead Cts. per Lb.	Zinc £ per Ton	Zinc Cts. per Lb.
26	27 1/16	90¼	90	121	25.76	178¼	178¾	32¼	6.86	92	19.59
27	26⅞	87⅞	89⅛	122	25.98	177⅛	178¼	32¼	6.86	91	19.37
28	27⅛	91¼	90¼	122	25.98	178¼	179	32⅛	6 83	91	19.37
29	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	27⅛	91⅞	91¼	124	26.41	179	179½	32	6.78	91	19.38
1	27	94⅛	94	124	26.41	179½	180¼	31⅞	6.73	90	19.16
2	27	94⅛	94	124	26.41	178⅞	179½	31⅛	6.67	90	19.15

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £ 15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21½c.

Other Metals

NEW YORK—Feb. 2

Aluminum—The market is quiet but steady. More metal seems to be available for early deliveries. Quotations are unchanged at 54@56c. per lb. for No. 1 ingots, New York.

Antimony—The market has been active and some good lots of Chinese have changed hands. The current quotation is 42½@43½c. per lb. for Chinese and other ordinary brands. Cookson's is still held at 56c. per lb., with small supplies available.

Antimony ore has sold this week at $2.25 per unit, in moderate lots.

William A. Burr, San Francisco, reports that he has just completed designs for a plant for the production of electrolytic antimony for the Wu-Gen Co., Canton, China. It is intended to produce five tons of antimony daily from 30% stibnite and realgar ores. It is claimed that this plant will attain a high extraction and that it will make a metal free from the ordinary impurities at a moderate cost.

Quicksilver—The market continues strong, with only limited supplies, and prices are high. New York quotations are $275@300 for large lots; $285@300 for smaller orders. San Francisco reports by telegraph $275 per flask, with the market quiet. London price remains at £16 15s. per flask, with the same quoted from second hands.

A lot of 600 flasks quicksilver was received at New York, Feb. 1; the consignment was to the American Express Co. It is understood in the trade that this is a special lot intended for a large explosive concern, and that it will not appear on the general market.

Nickel—The market is steady and sales good. Quotations are 45@50c. per lb. for ordinary forms, with 5c. per lb. premium for electrolytic metal.

Minor Metals—Current quotations for **Bismuth** are $4 per lb., New York.—**Cadmium** is quoted as 7s. per lb. in London; $1.50 per lb., New York.—**Chromium metal,** 75c. per lb., New York.—**Cobalt metal,** 97% pure, is sold at $1.25@1.50 per lb.—**Magnesium,** pure, has gone to a high price, $6 per lb. being asked.—**Selenium** varies from $2.50@3 per lb., New York, for large lots; $4.50@5 for retail quantities.

Gold, Silver and Platinum

NEW YORK—Feb. 2

Gold—Imports for the week at New York have been comparatively light.

Japanese papers report that the production of gold in Japan showed an increase of 20% in the nine months ended Sept. 30. The gold production in Chosen also increased 24% over the previous year.

Gold bullion deposited at the Canadian Assay Office at Vancouver, B. C., in 1915, showed an increase of $700,000 over 1914. Of the total last year $13,000,000 was from British Columbia, $1,150,000 from the Yukon and $2,000 from Alberta.

Exports of gold from the port of San Francisco 11 months ended Nov. 30 were $70,925, against $461,995 in 1914. Imports of gold showed a large increase, being $63,102,778, against $7,299,230 in 1914. A large sum was received from Japan.

Platinum—There is no material change in the market. Supplies are very scarce and sales are limited. Prices are irregular and it is difficult to fix quotations. Sales are reported at $85@95 per oz. for refined platinum, according to size and conditions of sale.

Silver—The market continues steady, with no new features. Outside of mintage orders there does not seem to be much business transacted. India is comparatively quiet, only small orders being received.

Zinc and Lead Ore Markets

PLATTEVILLE, WIS.—Jan. 29

Report for week ended Jan. 22, received too late for publication, give shipments for the week at 3,070,000 lb. zinc ore, 135,000 lb. lead ore and 761,100 lb. sulphur ore. Prices of 60% zinc ore, $108@113; for 80% lead ore, $76 per ton.

Jan. 29—The base price paid this week for 60% zinc ore was $113 down to $105 per ton. Base price paid for 80% lead ore was $78 per ton. No shipments of lead ore were reported.

SHIPMENTS, WEEK ENDED JAN. 29

	Zinc Ore, Lb.	Lead Ore, Lb.	Sulphur Ore, Lb.
Week	3,330,000	.....	776,300
Year	15,310,000	300,700	3,233,600

Shipped during week to separating plants, 5,112,000 lb. zinc ore.

JOPLIN, MO.—Jan. 29

Blende, high price, $111.90; base per ton 60% zinc, premium ore, $110; medium grades, $109@100, and lower grades down to $90; calamine, per ton 40% zinc, $80@70; average selling price, all grades of zinc, $103.73 per ton. Lead, high price, $82; base per ton 80% metal content, $80@82; average, selling price, all grades of lead, $79.65 per ton.

SHIPMENTS WEEK ENDED JAN. 29

	Blende	Calamine	Lead	Values
Totals this week..	13,308,740	1,551,750	2,040,330	$851,950
Totals this year..	48,770,370	5,044,560	7,735,550	$3,081,470

Blende value, the week, $714,640; the month, $2,603,910.

Calamine value, the week, $56,060; the month, $182,770.

Lead value, the week, $81,250; the month, $294,790.

Severe inroads were made this week on the few stocks of reserve ore, in filling the large buying orders for the various smelteries. Gas-fuel shortage is followed by the flooding of the hydro-electric plants, with a resultant shortage of this power. So far coal has been obtainable, but coal-mine floods are creating fears of a shortage in coal also. The month has a record of over 6 in. rainfall, and the heavy volume of water rising in the ground is becoming a serious menace to production, especially in north Webb City, where the flooding of mines along Center Creek is causing the water to raise in the mines farther away. A consultation of mine operators was held today to consider the problem, but no decision was reached.

Iron Trade Review

NEW YORK—Feb. 2

The iron and steel markets are quieter so far as new business is concerned, but this does not affect the mills with their great mass of orders ahead. Domestic orders show some signs of being checked by the high prices now asked. This is especially the case with structural steel and the smaller building material.

There is still much trouble with embargoes and delays on the railroads. Export business is struggling with high ocean freights and difficulty in finding vessel room.

The Mississippi Valley Iron Co. has been organized at St. Louis with $5,000,000 stock, by E. F. Goltra, D. R. Francis and other St. Louis men. The company will take over the property of the old St. Louis Blast Furnace Co. and will rebuild the furnace, increasing the capacity to 600 tons of pig iron daily. The ore supply will come from a tract lately bought near Waukon, Iowa.

Exports of billets, ingots and blooms from the United States in October were 43,405 tons. For the 10 months ended Oct. 31 they were 40,033 tons in 1914, and 451,306 tons in 1915; an increase of 411,273 tons.

Foreign Trade of the United States in iron and steel, including machinery, for the 10 months ended Oct. 31 is valued by the Department of Commerce as below:

	1914	1915	Changes
Exports	$169,232,670	$294,822,223	I. $125,589,553
Imports	24,974,754	16,675,915	D. 8,298,839
Excess, exports	$144,257,916	$278,146,308	I $133,888,392

The increase in exports was mainly in the later months. In October the exports were valued at $16,455,832 in 1914 and at $43,602,741 in 1915.

PITTSBURGH—Feb. 1

The general wage advance in the iron and steel industry becomes effective today in most instances. The Connellsville coke scale has just been posted, with a mining rate of $1.58 per 100 bu., the old rate having been $1.44, representing an advance of 9.7%, while other jobs were advanced 7 to 8%. This is the third successive advance without an intermediate reduction. In 1894, after the great strike, the mining rate was 78c. Coke then sold at less than $1 a ton.

Throughout the iron and steel industry there is a scarcity of labor, and a definite shortage, interfering to an extent with production, is feared within the next few months. Cars are not seriously short, but some inconvenience has already been experienced. The embargo on steel to be shipped from mill for export has been tightened. Export prices for most steel products, subject to the embargoes and subject to the buyer finding the vessel room, are higher than those in the domestic market.

The steel market is much quieter as to strictly new buying, but the general tone is still stronger. Specifications on contracts were very heavy in January, and the actual shipping orders on books are greater than at the beginning of the month. Some buyers of steel, those engaged in reinforced-concrete work, for instance, assert that the present high

prices will curtail consumption. The record of 23,000 freight cars ordered in January furnishes no indication that this is the case with respect to freight cars.

Pig Iron—The market continues very quiet, there being scarcely any inquiry, but prices have not weakened. The situation is regarded as very remarkable. In basic iron a buying movement is predicted for some time this month. The foundries have made little headway in connection with the molders' strike which began Dec. 13. We quote: Bessemer, $21; basic, malleable and forge, $18@18.50; foundry, $18.50@19, f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh. W. P. Snyder & Co. announce their computation of average prices obtaining in January on sales of Valley iron in lots of 1,000 tons and over at $20.645 for bessemer and $17.833 for basic, representing increases over the December averages of $1.624 and 34.6c. respectively.

Ferromanganese—There are few sellers on contract at $125, the price having become almost nominal, while prompt lots bring $160@175. Deliveries on contract are reported as fair, and the scarcity is attributed in some quarters to consumers not having covered freely enough.

Steel—The market for soft steel billets and sheet bars continues practically nominal, and quotable at about $32@33 for besemer and $35 for openhearth. Ordinary consumers could hardly afford to pay these prices, and must depend entirely upon steel due on contracts, while mills would probably ask more if they quoted. Forging billets made to war steel specifications are $55@60, while ordinary forging billets are held at $50@55. Rods are nominally $45 per ton at mill.

FERROALLOYS

Ferrovanadium—The price has advanced from $2 to $3 per lb. of contained vanadium. Exports in October were 166,972 lb.; in the 10 months ended Oct. 31 they were 815,835 lb.; an increase of 145,580 lb. over the previous year.

Ferrosilicon of high grade is in special demand, owing to the unusual silicon content demanded by some specifications for steel bars and shell material. Sales are reported at $90 up to $100 per ton at furnace for 80% alloy.

FOREIGN IRON

Foreign Iron Trade of Great Britain, year ended Dec. 31, as valued by the Board of Trade returns:

	Exports	Imports	Excess Ex.
Iron and steel	£40,421,958	£10,839,071	£29,582,887
Machinery, hardware, etc.	29,126,936	14,874,582	14,252,354
Total	£69,548,894	£25,713,653	£43,835,241
Total, 1914	89,494,295	24,026,721	65,467,574

Actual tonnage of iron and steel exported was 3,884,153 tons in 1914, and 3,199,121 tons in 1915; decrease, 685,032 tons. Imported, 1,618,015 tons in 1914, and 1,182,124 tons in 1915; decrease, 435,891 tons.

The German Iron and Steel Union reports the production of steel in Germany in November at 1,192,817 metric tons, being 22,470 tons less than in October. For the 11 months ended Nov. 30, the production was:

	Basic	Acid	Total
Converter	5,960,692	150,404	6,111,096
Openhearth	4,903,896	223,811	5,127,707
Direct castings	409,089	169,092	578,181
Crucible	.....	92,869	92,869
Electric	.....	115,072	115,072
Total	11,273,677	751,248	12,024,925
Total, 1914	13,449,384	568,524	14,017,918

The number of steel works in operation in 1915 was 247 in all.

Pig-Iron Make in Germany in November is reported by the German Iron and Steel Union at 1,019,122 metric tons, being 57,221 tons less than in October; 289,300 tons more than in October, 1914; and 568,166 tons less than in November, 1913. Production is about two-thirds of that in a normal year. For the 11 months ended Nov. 30 the total was: Foundry iron, 2,122,236 tons; forge iron, 259,823; steel pig, including spiegel, ferro and other alloys, 1,610,184; bessemer pig, 167,525; Thomas or basic pig, 6,601,225; total, 10,760,993 metric tons.

IRON ORE

Buying of Lake ore seems to be about over, all the larger contracts for the coming season having been closed. More transfers of Lake vessels are reported.

In the East there is a good deal of activity still in contracting for local ores. Pennsylvania and New Jersey ores have been in demand; also Lake Champlain ores.

Iron-Ore Imports in Great Britain for the year ended Dec. 31 were 5,704,748 long tons in 1914, and 6,203.161 tons in 1915; an increase of 498,413 tons, or 8.8%, last year.

Iron-ore exports from Sweden in the first 10 months of 1915 were 5,492,000 metric tons, against 4,191,000 tons to Nov. 1, 1914, a gain of 1,301,000 tons. In October alone these exports were 689,000 tons against 336,000 tons in October, 1914. The increases are probably due to the unusual shipments to Germany.

OTHER ORES

Manganese Ore imports into the United States for the year 1915, December partly estimated, were 312,908 tons, an increase of 30,612 tons over 1914. About 81% of the imports in 1915 were made in the second half of the year, nearly all coming from Brazil.

Imports of manganese ore in Great Britain for the year were 479,435 tons in 1914, and 377,324 tons in 1915; decrease, 102,111 tons.

Tungsten Ore has been sold for early and forward delivery at $55@60 per unit, and there are still buyers in the market at this price. In spite of these high figures, supplies remain very scarce.

COKE

Connellsville—Spot furnace coke is still rather scarce, and commands $3@3.25, with only light inquiry. There is not a sufficient car supply to ship any of the stock accumulated week before last, when the car supply was extremely light. Operators do not expect the labor supply to be increased by the general wage advance of Feb. 1 and fear the higher wages will cause the men individually to put in less time. Spot foundry coke is stronger and brings $4@4.50 for best brands.

Coal Production in Great Britain for the nine months ended Sept. 30 is reported by the Board of Trade at 202,603,000 long tons in 1914, and 189,943,000 tons in 1915; a decrease of 12,660,000 tons.

Fuel Exports of Great Britain, year ended Dec. 31, in long tons:

	1914	1915	Changes
Coal	59,039,880	43,534,771	D. 15,505,109
Coke	1,182,848	1,010,302	D. 172,546
Briquettes	1,607,757	1,225,071	D. 382,686
Steamer coal	18,535,615	13,630,964	D. 4,904,651
Total	80,366,100	59,401,108	D. 20,964,992

Steamer coal is the coal sent abroad for steamships engaged in foreign trade. Imports are negligible, being only 3,770 tons last year.

Foreign Fuel Trade of the United States 10 months ended Oct. 31, in long tons:

	Exports		Imports	
	1914	1915	1914	19150
Anthracite	3,406,491	2,956,578	19,295	2,8951
Bituminous	12,254,757	14,204,010	1,088,608	1,210,—
Coke	511,207	658,940	93,936	41,01
Bunker coal	6,285,770	6,311,987	.....	.....
				58
Total	22,458,225	24,131,515	1,201,839	1,254,733

The bunker coal or coal furnished to steamships in foreign trade is practically all bituminous. October exports of bituminous increased from 1,351,977 tons in 1914 to 1,782,450 in 1915, the larger shipments being to Italy chiefly.

Chemicals

NEW YORK—Feb. 2

The general market is inclined to be strong and higher prices are noted in several lines of trade.

Arsenic—The tone of the market is firmer and sales are reported at $5 per 100 lb. Producers ask $5.25, but have not yet succeeded in establishing that price.

Copper Sulphate—The market has been active with a good demand, especially for export. Prices are rather irregular, but firm, and $22@22.50 per 100 lb. for carload lots is named.

Pyrites—Arrivals at Baltimore for the week included 9,175 tons pyrites from Huelva, Spain.

Nitrate of Soda—A good demand is reported, notwithstanding the high prices. Orders from the chemical and explosives trades are good. Sales have been made as high as $3.45@3.50 per 100 lb., and some holders ask $3.55 for early deliveries.

Sulphuric Acid—Sales of 60% acid are reported at $25 per ton for early delivery and $22 for futures; both f.o.b. works, buyers to furnish tank cars.

PETROLEUM

During 1915, 10,218,788 bbl. crude oil were shipped from Tampico, Mexico, to United States ports, compared with 11,746,371 in 1914. During the last five months of 1915 the tankers' carrying capacity was reduced one-third by the sand bar which formed at the entrance to the Panuco River. Pressure is being brought to bear by the oil companies to have this bar dredged away, and their efforts will undoubtedly be successful.

Assessments

Company	Delinq.	Sale	Amt.
Albany Lead, Ida	Jan. 20	Feb. 19	$0.005
Andes Silver, Nev.	Jan. 21	Feb. 11	0.02
Atlantic, Ida	Jan. 21	Feb. 21	0.005
Baltimore Cons., Utah	Jan. 11	Feb. 11	0.002
Beaver Copper, Utah	Jan. 31	Feb. 21	0.005
Belmont, Ida	Feb. 15	Mar. 11	0.003
Big Elk, Ida	Jan. 25	Feb. 15	0.001
Cash Boy, Nev	Feb. 16	Mar. 20	0.01
Deer Creek C. & G., Utah	Feb. 5	Feb. 26	0.005
Emerald, Utah	Jan. 15	Feb. 12	0.00½
Emerald, Utah	Feb. 15	Mar. 11	0.00½
Emerald, Utah	Mar. 15	Apr. 11	0.00½
Empire M. & D. Ida	Jan. 15	Feb. 15	0.005
Enterprise, Ida	Feb. 4	Feb. 16	0.002
Exchequer G. & S., Nev	Feb. 16	Mar. 8	0.03
Giant, Nev	Jan. 29	Feb. 12	0.0025
Gold Mt. Champion, Utah	Jan. 21	Feb. 8	0.0025
Hale Norcross, Nev	Jan. 25	Feb. 15	0.03
Imlay, Nev	Jan. 7	Feb. 8	0.01
Imperial, Ida	Feb. 19	Mar. 20	0.003
Independence, Utah	Jan. 20	Feb. 14	0.001
Index, Ida	Feb. 6	Mar. 6	0.0025
Jacket-Crown Pt.-Belc., Nev	Feb. 18	Mar. 10	0.06
Laclede, Ida	Feb. 4	Feb. 28	0.003
Lucky Swede, Ida	Jan. 11	Feb. 11	0.002
Massasoit, Utah	Jan. 13	Feb. 23	0.015
M. & P. Gold, Utah	Feb. 7	Feb. 21	0.0025
McKinley Gold, Ida	Jan. 28	Feb. 24	0.0005
Mexican Nev	Jan. 25	Feb. 16	0.10
Monarch Pitts., Nev	Feb. 18	Mar. 20	0.01
Nabob, Ida	Jan. 17	Feb. 14	0.005
Nevada-Douglas, Nev	Feb. 10	Mar. 10	0.10
Ophir, Nev	Jan. 19	Feb. 10	0.05
Revenue Cons., Utah	Feb. 5	Mar. 3	0.01
Rexall, Utah	Feb. 2	Feb. 21	0.01
Rob Roy, Ida	Feb. 5	Mar. 5	0.002
Santaquin King, Utah	Feb. 8	Mar. 8	0.00125
Scorpion, Nev	Feb. 21	Mar. 14	0.01
Sierra Nevada, Nev	Jan. 19	Feb. 9	0.10
Slavonian, Ida	Feb. 1	Feb. 29	0.001
Snowshoe, Ida	Feb. 15	Mar. 15	0.005
Superior & Boston, Mich	Feb. 7		1.00
Tar Baby, Utah	Dec. 31	Feb. 28	0.005
Tyler M. & M., Ida	Jan. 28	Feb. 28	0.001
Utah-Oregon, Utah	Jan. 5	Feb. 10	0.0005
Victor Cons. Utah	Jan. 19	Feb. 7	0.015
Western Star, Ida	Jan. 10	Jan. 31	0.001

Stock Quotations

COLO. SPRINGS	Feb. 1	SALT LAKE	Feb. 1
Name of Comp.	Bid.	Name of Comp.	Bid.
Acacia	.05	Beck Tunnel	.09½
Crippie Cr'k Con.	.009	Black Jack	.10
Dante	.04	Colorado Mining	.14½
Doctor Jack Pot	.10½	Crown Point	.04½
Elkton Con	.34½	Daly-Judge	8.00
El Paso	.97	Emma Cop	.37
Findlay	.03½	Gold Chain	.56
Gold Dollar	.03	Grand Central	.57
Gold Sovereign	.04½	Iron Blossom	1.32½
Golden Cycle	2.17½	Lower Mammoth	.07
Isabella	.23½	May Day	.21
Jack Pot	.06½	Opohongo	.02½
Jerry Johnson	.06½	Prince Con	.77
Lexington	‡.005	Seven Troughs	.01½
Mary McKinney	.45	Silver King Coal'n	3.40
Pharmacist	‡.01	Silver King Con	2.32½
Portland	1.80	Sioux Con	.08½
Raven B. H.	.02½	Uncle Sam	.08½
Vindicator	2.46	Yankee	.31

SAN FRANCISCO	Feb. 1		
Alta	.05	Belmont	4.20
Andes	.10	Jim Butler	.90
Best & Belcher	.04	Lone Star	.03
Caledonia	.48	MacNamara	.04
Challenge Con	.06	Midway	.15
Chollar	.02	Mont.-Tonopah	.28
Confidence	.20	North Star	.14
Con. Virginia	.10	Rescue Eula	.07
Gould & Curry	.02	West End Con	.73
Hale & Norcross	.03	Atlanta	.20
Jacket-Cr. Pt.	.06	Blue Bell	.02
Julia	.01	Booth	.43
Mexican	.24	C.O.D. Con	.03
Occidental	.75	Comb. Frac	.07
Ophir	.23	D'field Daisy	.03
Overman	.05	Jumbo Extension	1.22½
Savage	‡.04	Pitts.-Silver Peak	.07
Seg Belcher	.04	Round Mountain	.46
Sierra Nevada	.33	Sandstorm Kendall	.05
Union Con	.59	Silver Pick	.03
Utah Con	.01	Central Eureka	.08

TORONTO	Feb. 1		
Bailey	‡.04½	Dome Exten	.29½
Chambers Ferland	.24	Dome Lake	‡.26
Coniagas	4.20	Foley O'Brien	.60
La Rose	.65	Hollinger	29.75
Peterson Lake	.29	Imperial	‡.04
Right of Way	‡.06	Jupiter	.20½
Seneca Superior	.90	McIntyre	.94
T. & Hudson Bay	25.00	Porcu. Crown	.82
Temiskaming	.67½	Preston E. D.	‡.05
Trethewey	.16	Vipond	.69
Wettlaufer-Lor	.08	West Dome	.14½

LONDON	Jan. 16		
Alaska Tre'dwell	£7 5s 0d	Mexico Mines	£4 0s 0d
Burma Corp	1 12 6	Nechi, pfd	0 14 6
Cam & Motor	0 14 3	Oroville	0 12 6
Camp Bird	0 7 0	Santa Gert'dis	0 9 9
El Oro	0 8 9	Tomboy	1 3 1½
Esperanza	0 10 0	Tough Oakes	0 11 10½

N. Y. EXCH.	Feb. 1	BOSTON EXCH	Feb. 1
Name of Comp.	Cig.	Name of Comp.	Cig.
Alaska Gold M	24	Adventure	1½
Alaska Juneau	9½	Ahmeek	397½
Am.Sm.&Ref.,com	98½	Algomah	1½
Am. Sm. & Ref., pf.	114	Allouez	67½
Am. Sm. Sec., pf. A	91½	Ariz. Com., ctfs.	8½
Am. Sm. Sec., pf. B	86½	Bonanza	.35
Am. Zinc	67½	Butte Alex. Scott	9½
Anaconda	84½	Butte-Ballaklava	4
Batopilas Min.	2‡	Calumet & Ariz.	69½
Bethlehem Steel	465	Calumet & Hecla	550
Bethlehem Steel, pf.	128	Centennial	16½
Butte & Superior	77½	Copper Range	62½
Chile Cop.	22½	Daly West	2½
Chino	52½	East Butte	14½
Colo. Fuel & Iron	43½	Franklin	9½
Crucible Steel	76	Granby	91½
Dome Mines	28½	Hancock	17
Federal M. & S.	25	Hedley	26
Federal M. & S., pf.	52½	Helvetia	.40
Great Nor., ore., ctf.	44½	Indiana	4½
Greene Cananea	47½	Island Cr'k, com	47
Guggen. Exp.	22½	Island Cr'k, pfd	88½
Homestake	127½	Isle Royale	27
Inspiration Con	44½	Keweenaw	2½
International Nickel	205½	Lake	16½
Lackawanna Steel	81½	La Salle	4½
Miami Copper	35½	Mason Valley	3½
Nat'l Lead, com	67½	Mass	11½
National Lead, pf.	114	Mayflower	3½
Nev. Consol.	15½	Michigan	1½
Ontario Min	8	Mohawk	89
Quicksilver	5½	New Arcadian	8½
Quicksilver, pf.	7½	New Idria	19½
Ray Con	23½	North Butte	27½
Republic I&S, com.	50½	North Lake	1½
Republic I&S, pf.	108	Ojibway	1½
Sloss-Sheffield	56½	Old Colony	3
Sloss-Sheffield, pf.	96	Old Dominion	62½
Tennessee Copper	55½	Osceola	85½
Utah Copper	77½	Quincy	89
U. S. Steel, com	82½	St. Mary's M. L.	62
U. S. Steel, pf.	116	Santa Fe	3½
Va. Iron C. & C.	50	Shannon	9
		Shattuck-Ariz.	32½
N. Y. CURB	Feb. 1	So. Lake	6½
Alta Con	.20	Superior	22½
Beaver Con	.35	Superior & Bost.	3
Big Four	.04	Tamarack	50
Buffalo Mines	1	Trinity	9½
Butte & N. Y.	2½	Tuolumne	.20
Butte C. & Z.	7½	U. S. Smelting	56
Can. Cop. Corpn.	1 3/16	U. S. Smelt'g, pf.	49½
Cashboy	.04	Utah Apex	3½
Cerro de Pasco	37½	Utah Con	13
Con. Ariz. Sm.	1 1/16	Victoria	3
Con. Coppermines	1.68¾	Winona	3½
Con. Nev.-Utah	⅛	Wolverine	61
Dia. Black B.	.03	Wyandot	2
Florence	.47		
Goldfield Con.	.94	BOSTON CURB	Feb. 1
Goldfield Merger	.18	Bingham Mines	7½
Hecla Min.	3 13/16	Boston Ely	.53
Howe Sound	6½	Butte & Lon'n Dev.	.37
Kennecott Cop.	52	Calaveras	3
Kerr Lake	4½	Calumet-Corbin	.06
Magma	15	Chief Con	1⅛
Majestic	1½	Cortes	.60
McKinley-Dar-Sa	.45	Crown Reserve	.35
Mines of Am	2½	Davis-Daly	1½
Mother Lode	.22	Eagle & Blue Bell	1½
Nevada Hills	.20	First Nat. Cop	6½
New Utah Bingham	3½	Houghton Copper	2½
Nipissing Mines	7⅛	Iron Cap Cop., pf.	7½
Oro	.05	Mexican Metals	.45
Ray Hercules	3½	Nat. Zinc & Lead	2⅛
Rochester Mines	.60	Nevada-Douglas	.82
St. Joseph Lead	‡15½	New Baltic	3½
South Utah	.25	New Cornelia	12
Stand'd Oil of N.J.	499	Ohio Copper	.18
Standard S. L.	1½	Oneco	1½
Stewart	.50	Raven Copper	12
Success	.76	Rex Cons	.29
Tonopah	6 13/16	Rilla	1 1/16
Tonopah Ex.	4 1/16	Smokey Dev	‡.30
Tonopah Merger	.60	United Verde Ext.	6 13/16
Tribullion	.50	Utah Metal	8½
White Knob, pf.	1½		
Yukon Gold	2½	‡Last Quotations.	

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1914	1915	1916	1914	1915	1916
January	56.572	48.855	56.775	26.553	22.731	26.953
February	57.506	48.477	.....	26.573	22.753	.....
March	58.067	50.241	.....	26.788	23.708	.....
April	58.519	50.250	.....	26.958	23.709	.....
May	58.175	49.915	.....	26.704	23.570	.....
June	56.471	49.034	.....	25.948	23.267	.....
July	54.678	47.519	.....	25.219	22.597	.....
August	54.344	47.163	.....	25.979	22.780	.....
September	53.290	48.680	.....	24.260	23.591	.....
October	50.654	49.385	.....	23.199	23.925	.....
November	49.082	51.714	.....	22.703	25.094	.....
December	49.375	54.971	.....	22.900	26.373	.....
Year	54.811	49.604	.....	27.314	23.675	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York		London			
	Electrolytic		Standard		Electrolytic	
	1915	1916	1915	1916	1915	1916
January	13.641	24.008	60.756	88.083	65.719	116.17
February	14.394	.....	63.494	.....	*	.....
March	14.787	.....	66.152	.....	*	.....
April	16.811	.....	75.096	.....	*	.....
May	18.506	.....	77.600	.....	*	.....
June	19.477	.....	82.574	.....	95.333	.....
July	18.796	.....	76.011	.....	91.409	.....
August	16.941	.....	68.673	.....	82.333	.....
September	17.592	.....	68.915	.....	85.250	.....
October	17.686	.....	72.601	.....	88.000	.....
November	18.627	.....	77.744	.....	93.273	.....
December	20.133	.....	80.773	.....	100.43	.....
Year	17.275	.....	72.532	.....	.....	.....

TIN

Month	New York		London	
	1915	1916	1915	1916
January	34.260	41.825	156.550	175.548
February	37.415	.....	176.925	.....
March	48.426	.....	180.141	.....
April	47.884	.....	166.225	.....
May	38.790	.....	162.675	.....
June	40.288	.....	167.636	.....
July	37.423	.....	167.080	.....
August	34.389	.....	151.440	.....
September	33.125	.....	152.625	.....
October	33.080	.....	151.554	.....
November	39.224	.....	167.670	.....
December	38.779	.....	167.000	.....
Av. year	38.500	.....	163.960	.....

LEAD

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
January	3.729	5.921	3.548	5.826	18.606	31.167
February	3.827	.....	3.718	.....	19.122	.....
March	4.053	.....	3.997	.....	21.883	.....
April	4.221	.....	4.142	.....	21.094	.....
May	4.274	.....	4.182	.....	20.347	.....
June	5.932	.....	5.836	.....	25.170	.....
July	5.659	.....	5.531	.....	24.611	.....
August	4.656	.....	4.520	.....	21.946	.....
September	4.610	.....	4.490	.....	23.151	.....
October	4.600	.....	4.499	.....	23.994	.....
November	5.155	.....	5.078	.....	26.278	.....
December	5.355	.....	5.266	.....	28.807	.....
Year	4.628	.....	4.587	.....	22.917	.....

SPELTER

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
Jan.	6.386	16.915	6.211	16.745	30.844	89.810
Feb.	8.436	.....	8.255	.....	39.819	.....
Mar.	8.541	.....	8.360	.....	44.141	.....
April	10.012	.....	9.837	.....	49.888	.....
May	14.781	.....	14.610	.....	68.100	.....
June	21.208	.....	21.038	.....	100.614	.....
July	19.026	.....	18.856	.....	97.250	.....
Aug.	12.781	.....	12.611	.....	67.786	.....
Sept.	13.440	.....	13.270	.....	67.841	.....
Oct.	12.800	.....	12.596	.....	66.536	.....
Nov.	15.962	.....	15.792	.....	88.409	.....
Dec.	15.391	.....	15.221	.....	89.400	.....
Year	13.230	.....	13.054	.....	67.553	.....

New York and St. Louis quotations, cents per pound, London, pounds sterling per long ton. * Not reported. ‡ London Exchange closed.

PIG IRON IN PITTSBURGH

Month	Bessemer		Basic		No. 2 Foundry	
	1915	1916	1915	1916	1915	1916
January	$14.59	$21.60	$13.45	$18.78	$13.90	$19.70
February	14.55	.....	13.45	.....	13.90	.....
March	14.55	.....	13.45	.....	13.95	.....
April	14.55	.....	13.45	.....	13.95	.....
May	14.64	.....	13.60	.....	13.83	.....
June	14.70	.....	13.67	.....	13.77	.....
July	14.94	.....	13.91	.....	13.68	.....
August	16.01	.....	15.31	.....	14.75	.....
September	16.86	.....	15.95	.....	15.70	.....
October	16.95	.....	15.96	.....	15.80	.....
November	18.26	.....	17.30	.....	17.20	.....
December	19.95	.....	18.95	.....	18.95	.....
Year	$14.89	.....	$13.76	.....	$13.89	.....

The Mining Index

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